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With an Introductory Note by

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THE INDUSTRIAL STATE

By the middle of the nineteenth century the political consequences of the industrial revolution were manifest. They indicated that the economic control of the earth's resources would fall to the great manufacturing nations. The Crystal Palace Exhibition of 1851, and the series of exhibitions which followed, expressed the fact that manufacturing had become in a new sense a basis of world power. This development embodied certain discordant features. Modern industry is cosmopolitan in that it procures its materials and markets its products in all parts of the globe; but as a source and a beneficiary of political strength it integrates along national lines. Small industrial nations like Belgium and Switzerland prove that manufacturing progress may occur without a powerful government; and great countries like Russia have been backward in factory pursuits. But in spite of such inharmonious tendencies and exceptions, the net result of this phase of economic evolution was to create a new political concept and a new productive unit, which we may denominate the industrial state.

Attempts to realize this concept through private effort and government policy have shaped increasingly the international environment of industry during the past sixty years. Germany strove strenuously and consciously toward this goal; England evinced growing concern to maintain her ancient manufacturing supremacy; France embarked upon a vast colonial program partly to assure herself raw materials and markets for her industry; and a neo-mercantilism influenced profoundly the national policy of all western Europe and Japan.

This renewed alliance of industry and government—a relationship which advanced nations seemed about to discard earlier in the century—resulted from the changed system of production which mechanical inventions brought about. Prior to their introduction every nation was practically self-subsisting; manufacturing was dispersed, or if localized it was confined to small areas within larger agricultural communities; each state contained the means of continued existence and growth within itself. British cotton spinning was the first grand industry to depend entirely on imported materials. The localization of a great manufacture so distant from its sources of supply was as radical an innovation in industrial geography as was Arkwright machinery in industrial mechanics. With improved trans-

portation the same movement of particular branches of manufacturing, and of large groups of manufactures, into districts of centralized production, which draw to themselves materials from the most distant regions, has gone on apace. This specialization of pursuits has made the people of western Europe in particular dependent upon the products of other continents, and has caused their political relations with those continents to become for them a matter of vital national importance.

AMERICA'S EXCEPTIONAL POSITION

In many respects the development of manufactures in the United States during the last half of the nineteenth century was parallel with that of Europe. But conditions in our country differed from typical conditions across the Atlantic in two important ways. In the first place we continued to make goods almost entirely for home consumption at a time when other large manufacturing nations were producing for export markets. Our people formed the largest consuming unit in the world—measured by population, purchasing power and standard of living—and one that was rapidly expanding; so we had little inducement to seek foreign customers. In the second place, while the manufacturing expansion of Europe depended upon carrying raw materials to labor, the industrial progress of the United States was the result of carrying labor to raw materials. These features had distinguished American manufacturing from its origin; but their persistence into a period when our industries ranked in extent and technical perfection with those of Europe was a novel condition which constantly influenced their form and organization.

Since our factory products were taken so largely by domestic consumers, our industrial growth was not checked by the loss of our carrying trade and merchant marine at the time of the Civil War. Indeed competition for sea control and colonies, which throughout this period inspired the ambitions and engendered the controversies of other industrial states, played no part in our manufacturing history at this time. Our economic life continued to be founded so largely upon native resources, that we became the sole example of an industrial nation of the first rank that was practically self-contained. While Europe exploited and developed foreign continents, we were subduing our own. Just at the turn of the century we became a colonial power. For whatever term we may apply for political consistency's sake to our tropical dependencies, they are colonies so far as their commercial and industrial relations with ourselves are concerned. But these colonies were not acquired under economic stress. We accepted them primarily neither for their raw materials nor for their markets. They were the gifts of a political accident—or perhaps more truly of a political inevitability in which conscious economic motives played a minor part. But from the time of their acquisition, dates popular national interest in overseas markets for our manufactures.[1]

[1] Our exports of manufactures first exceeded our imports of manufactures in 1898. *Cf.* America Iron and Steel Association, *Bulletin*, XXXIII, 147, Sept. 1, 1899.

At first this interest was more theoretical than practical. Some people expected industrial expansion beyond our frontiers to follow political hegemony. They believed stoutly that "trade follows the flag." In a milder interpretation we expected our business ventures in South America to bud and blossom under the benignant radiance of the Monroe Doctrine. But these genial anticipations were not pressed upon us then by an urgent need of export markets. They were inspired partly by memories of our schooner-trading ancestors who trafficked in the Spanish Main, and partly by political sentimentalism. It was not until the verge of the World War that we began to look beyond our borders with a really keen eye for business. Our industries had now reached a point where native raw materials no longer could supply them, and where home markets could not absorb their products.

Therefore throughout this period the United States occupied an exceptional and preferred position in the midst of a group of industrial states which did not represent, as we did, nearly complete and self-sufficient economic units, and which consequently were impelled by the instinct of self preservation to a rivalry which defeated its own purpose and brought them to the verge of common ruin. We can now interpret the past fifty or sixty years in the light of their outcome. The key to that era's meaning is found in the tragic climax which terminated it, and which prepares us better to understand the international environment in which the United States attained maturity as a manufacturing nation.

NATIONAL VERSUS COSMOPOLITAN INFLUENCES

The keen, aggressive rivalry among European industrial states invigorated protectionism. Free-trade Britain found no imitators. A complex network of commercial treaties, made more complex by most favored nation clauses, defeated the original object of such agreements as were embodied in the Treaty of 1860 between France and England, and added to the general artificiality with which nationalism cramped economic processes. The industrial state became not merely a defensive organism, sheltering its own producers, but an aggressive and destructive agency, intent on overthrowing every obstacle in the way of world expansion and crushing every competitor in the world market. Its own larger interest demanded this; for no industrial state could feed from its own fields the multiplied population within its own borders. It faced the alternative of foreign markets or famine.

The direct effect upon the United States of this spirit, and of the policies it begot, was negligible. We adjusted our own tariffs to conditions of international rivalry to be sure; but in order to shelter our manufacturers from destructive competition, not to destroy our competitors. This let-live attitude was not due to our native generosity, but to the same conditions that spared us the bitter hatreds of rival European nations. We had no reason to begrudge other countries the raw materials and markets they

won in newer lands because we did not need them for ourselves. Now we are beginning to take a livelier interest, for instance, in petroleum fields beyond our own borders, and this interest may extend shortly to other minerals and timber. When foreign markets begin to decide whether our workers shall have a full or an empty dinner pail, we too may become relentless rivals of competing industrial states. For in the same way that political nationalism makes peace an armed truce, so economic nationalism makes the competition between states a truceless war.

Throughout this period, therefore, industry was increasingly regarded as a political rather than a social asset, as an instrument for national aggrandizement rather than for increasing the well-being of the masses. Consequently it promoted rivalries and divisions among governments. Simultaneously, however, it increased their interdependence. For freed from the external accidents of nationality and politics, industry is itself a harmonizing and unifying social influence. It intermingles and interrelates races and peoples, and tends to combine all nations into a single higher economic organism. The Atlantic cable made possible a world market, where demand and supply become instantly cognizant of each other, no matter though they were separated by half the circumference of the globe. Cheap locomotion facilitated the ebb and flow of labor according to seasonal employment and to the activity or lethargy of industry in different countries and hemispheres. In spite of tariffs and other measures to control the geography of manufactures by legislation, the international division of labor increased; and the exchange of commodities among peoples was so facilitated by the instantaneous communication of commercial intelligence, and by speedy, cheap and reliable transportation, that trade grew faster than either population or production.

So two opposing forces struggled to control the development of manufacturing. Nationalism—exclusive, self-centered, destructive in its rivalries—strove to group industries according to political frontiers: internationalism, inspired by purely economic motives—devoid of idealism or sentiment, but irresistibly moving along the very path that conscious humanitarian interest would have trod—sought to distribute industry according to a law of maximum utility, so that each art and occupation might ultimately be centered where it would produce the most with the least cost and effort.

Another counter influence tending to break down the exclusiveness of the industrial state was the international community of science. The dependence of the manufacturer upon the scientist grew with each passing year; and happily the labors of the human intellect recognize no national frontiers. In the older days of rule of thumb, when manufacturing implied first and foremost manual dexterity in a special art, crafts and guilds might have their "mysteries." Great Britain, as we have seen, tried to prevent the emigration of skilled artisans and prohibited the exportation of novel machinery. But such governmental measures to preserve a monopoly of

certain manufactures for a single nation proved impossible of enforcement and were soon relinquished. Even today some firms and industries—for instance the optical glass makers of France and Belgium—try to conceal the secrets of their craft. Germany has treated her dye formulas almost as a national asset. But our experience during the recent war proved that science had only to turn the eye of research on these mysteries to read their secret, and indeed to improve upon the empirical wisdom their possessors are so solicitous to hide.

By thus making a common fund of the fruits of research, discovery and invention, the civilized nations during the past fifty years have multiplied their aggregate wealth and productive resources. The chemical and the steel industries of Germany were based largely upon discoveries made by English and French scientists. America received much of its metallurgical lore from abroad; yet the world's aluminum industry is founded upon processes developed in our country.

This was also a period of labor migration on a scale previously unknown in history. The common people of different countries intermingled to an extent never before possible in times of peace. These mass movements of workers tended to standardize manufacturing along cosmopolitan lines and thus to equalize international competition. Migrating labor has been mostly unskilled labor, and where it is employed in manufacturing old craft traditions disappear and machinery takes the place of skill.

Industrial promotion and finance, and consequently industrial management, also disregard national boundaries. Our International Harvester Company had immense works near Moscow; the British branch of the Singer Sewing Machine Company became a powerful independent corporation and operated and owned one of the finest factories and factory towns in Russia; and the General Electric Company has factories operated by allied and partly independent corporations, in Japan and China. Industrial states have colonies to supply them with exotic produce; and similarly great industrial companies acquire mines, estates, forests, wharfs and warehouses in foreign countries, to feed their furnaces and factories. The Pennsylvania Steel Company owned and operated mines in Cuba while that island was still under Spanish rule; The Bethlehem Steel Company is developing vast iron deposits in Chile; and our rubber manufacturing companies control plantations in the tropical antipodes.

So a conflict between nationalism and internationalism characterized the world evolution of industry during the period we are to discuss. Other and perhaps more generally recognized features of that period are the familiar unprecedented progress in the technology of manufacturing and in the volume of goods produced; and the enlargement of the manufacturing unit, until in some instances it embraces under centralized control practically an entire branch of industry within a nation.

In our own manufacturing annals the era whose guiding tendencies we have just sketched is conveniently bounded by the beginning of two wars—

the one between Northern and Southern States and the one between the world coalitions. Within the 54 years from 1860 to 1914 occurred a greater quantitative expansion of industry than in all the previous history of the race.

Nevertheless the dramatic incidents of history so focus our attention that they subordinate unduly attendant circumstances of first importance, and present themselves as the creators of the very conditions which give them birth. Not improbably we and our successors for years to come shall interpret the recent world war as the origin of a social and economic, as well as a political revolution, of which it was only an intermediate—though indeed a critical and tragic—phase. In like manner we are inclined to attribute to the stress of the Civil War the beginning of our transition from a planting to a manufacturing nation, although the struggle of itself changed no existing economic tendency in America, and like a whirlpool in a river neither contributed to the volume of our production nor permanently diverted its direction.

CHAPTER II

GENERAL BUSINESS CONDITIONS IN THE NORTH 1860–1865

CONDITIONS IN THE NORTH AT THE OUTBREAK OF THE CIVIL WAR

During the decade that preceded 1860 the country had made the most remarkable industrial progress in its history. Railways had extended until they began to form a truly national system of communication; settlement had spread rapidly through the prairie states and upon the Pacific Coast; our foreign commerce was unprecedented; immigration was increasing; and new natural resources—not only the precious metals from the West, but copper and iron from Lake Superior—were developed. In spite of the financial crisis of 1857, the nation was prospering and growing as never before when the war broke out.

No form of production had responded more promptly or more fully to the encouragement afforded by these conditions than manufacturing. During these ten years our iron and textile industries had grown two-thirds. Although premonitory symptoms of the coming decline of our merchant marine appeared before 1860, American shipyards at that time built—not sporadically, but as a regular business—commercial and war vessels for other countries, and equipped them with all the appliances of steam navigation. Our locomotive works sent a substantial share of their output to Europe. We were probably in advance of any other nation in the use of interchangeable mechanism and in the application of automatic machinery to producing standard parts. A commission sent by the British Government to America soon after the Crystal Palace Exhibition, to study our machinery, reported that more than one hundred different automatic power-tools were used to shape the parts of a Springfield rifle. The Colt Arms Works at Hartford were probably the finest establishment of the kind in the world. Before the war we made both military rifles and the machinery to manufacture them for the British and other foreign governments, and even in the midst of hostilities New England makers produced equipment for European arsenals.

We had applied factory methods of mechanical production not only to making firearms, but also to the manufacture of clocks and watches, sewing machines, and agricultural and textile machinery. In a word, the factories and workshops of New England and the Central States were already prepared to equip armies and to replace the waste of modern war.[1] We did

[1] *Cf.* National Association of Wool Manufacturers, *Bulletin*, IX, 55–56, Jan. 1879.

not have to create these establishments when hostilities began, but only to transform them to military uses.

If the war did not create new manufactures, neither did it revolutionize industrial labor in the northern states. For fifteen years or more English-speaking and German immigrants had been crowding into our factories and workshops. British and Irish operatives already predominated in the cotton factories of Rhode Island, and Welsh and Scotch ironmakers manned the furnaces and rolling mills of Pennsylvania.

Protracted and destructive as was the war between the North and the South, it was not in a modern sense a war of equipment. Had that been the case the Confederacy could not have survived through four years of blockade and isolation. Yet the conflict naturally threw a heavy additional load upon the industries of the country, to which they had to be accommodated. In this readjustment America was greatly aided by the elasticity of its productive machinery, due to abundant raw materials, an adaptable and inventive population, and past experience with the sudden market expansions that frequently occur in a rapidly developing country.

Not only did the United States at this time produce its own raw materials[2] but the states loyal to the Union, which contained most of the manufacturing establishments, were themselves nearly self-sufficing. Except cotton, no important article they used came from south of Mason and Dixon's line. They at all times held open the sea routes from other countries, and during the latter half of the war they occupied southern territories which supplied them with considerable quantities of cotton.

EFFECT OF HOSTILITIES ON GENERAL BUSINESS

During the first year of the conflict the shock to business caused by political unsettlement, by the loss of southern markets, by the non-payment of large sums due from southern debtors, and by the distraught condition of the public mind, caused a commercial depression. Immediately following the presidential election, in the fall of 1860, a sharp money panic occurred. Most of the Pennsylvania, Maryland and Virginia banks suspended specie payment. Country drafts on New York rose to a premium of 5 and 10 per cent, so that customers' remittances to the financial and manufacturing centers were checked.[3] Some large factories worked short time although they had abundant orders, because they could not get money.[4] Crops were good and people were ready to buy, but the financial machinery was out of joint. As a result business was stagnant during the ensuing winter.

By this time states were seceding in rapid succession, and even the stimulus of a new tariff law, considerably increasing the protection previously given manufacturers, did not attract capital into new industries or cause the enlargement of old ones. Although the South still sold cotton freely

[2] *Cf. Rebellion Records*, Ser. III, vol. II, 853.
[3] *Scientific American*, III, 364, Dec. 1, 1860.
[4] *Scientific American*, III, 408, Dec. 22, 1860.

to northern customers, the spring movement of that commodity from the receiving ports to New England and eastern mills declined to half what it had been the preceding year.[5] As soon as hostilities actually began money became abundant, but trade continued to hesitate throughout the following summer. Fifteen slave states and six free states were not paying their debts to the East, on account of secession or of prohibitive rates of domestic exchange, and several dry-goods houses in New York consequently failed or had to ask extensions from their creditors.[6] These houses were in turn indebted to American manufacturers or were directly interested in manufacturing enterprises. So commercial embarrassment and distress were immediately communicated to industrial circles.

This situation was relieved before the year was over by two things: the West shipped to the seaboard a large grain crop for which there was a good demand abroad, thus settling its account with eastern houses, and the Government placed with manufacturers what were then considered enormous contracts for cloth, clothing, boots and shoes, and military munitions and eqiupment. Railroad receipts increased, and western land office sales were active. Throughout the country there was evidence of a rising tide of prosperity.[7]

Hitherto goods had been sold on long credits of eight or ten months, and sometimes from crop to crop. This method of doing business encouraged country dealers to keep large quantities of merchandise in stock, sufficient for a whole season's trade. This had been a useful custom in former times, when transportation was not only uncertain but also seasonal —declining to a minimum when canals and rivers were stopped by ice and highways were blocked by snow or rendered impassable by thaws and rains. War uncertainties at once shortened credits to thirty days at utmost, and changed a large part of the country's business to a cash basis. Railways made deliveries possible at all seasons. As a consequence of these two conditions merchants bought in smaller quantities and at more frequent intervals.[8]

All these readjustments to the new situation created by the war were sufficiently advanced at the close of the first year of hostilities to restore confidence; and in general the industries of the country continued prosperous throughout the remainder of the conflict.[9]

To be sure, this prosperity was highly artificial and speculative. It was based partly upon a war market that might vanish at short notice, partly upon an abnormal rise of prices due to currency inflation, and partly upon an opinion that the needs of the Treasury would necessitate, for an indefinite time, customs duties that would give liberal protection to manufacturers.

[5] *Hunt's Merchants' Magazine*, XLIV, 327, Mar. 1861.
[6] *New York Economist*, quoted in *De Bow's Review*, XXXI, 93–94, July 1861.
[7] *Scientific American*, V, 11, July 6, 1861.
[8] *Annual Statement of the Trade and Commerce of Cincinnati*, 1862; *Scientific American*, VII, 68, Aug. 2, 1862; X, 281, Apr. 30, 1864; XIII, 274, Oct. 28, 1865.
[9] *Atlantic Monthly*, XI, 86, Jan. 1868.

WAR MARKET FOR MANUFACTURES

The war market for goods produced in the North was of a three-fold character, supplying respectively the army, the civilian population and the export trade. Only a rough estimate can be made of the army's demand for goods. Between 1860 and 1865 the government's annual expenditures rose from $60,000,000 to nearly $1,218,000,000.[10] Allowing for the depreciation of the currency in 1864, the latter sum was equivalent to something over $500,000,000 in the money of 1860. Part of the increased outgo represented the pay of officers, enlisted men and additional civilian employes required in time of war. For a time it included money sent abroad for imported materials and manufactures. Moreover the goods used by the army and navy were partly transfers from civilian to military consumption. A soldier who was wearing a uniform would in peace have been wearing an ordinary suit. Yet after making these deductions a vast excess of manufactured articles was consumed because the country was at war.[11] During the last year of hostilities the combined expenditures of the ordnance and quartermaster's departments, for artillery and small arms, ammunition, clothing, and camp and garrison equipage for the army alone approached $150,000,000 in currency;[12] and practically all of these supplies were manufactured in America. At the time the census of 1860 was taken the net product of the whole nation's manufacturing industries was valued at about $800,000,000. It is not unlikely that the war market of the North alone took home manufactures worth one-fourth this amount.

Meanwhile northern manufacturers lost a market in the South, whose planters previously purchased many of their products. Indeed it was partly because northern furnaces and mills were relieved of the task of supplying the South, that they were able so readily to meet the increased demand of the North. Part of this southern market was recovered even during hostilities. As early as the summer of 1862 orders for goods began to reach New England from New Orleans and other southern cities, "which have been made submissive to legal authority."[13]

While the civilian market was thus lessened in area by secession, it nevertheless grew rapidly within the temporarily curtailed territories under northern jurisdiction. Inflation and war profits stimulated trade. Abundant money and rising wages extended the popular use of comforts and luxuries. Cut off for a time from its Mississippi outlet to tidewater, and from its market for provisions in the cotton states, the West threw all its heavy traffic into the Great Lakes and railway channels to eastern ports.

[10] *Total Net Ordinary Expenditures, Excluding Interest and Principal on Public Debt, and Postal Service:* Department of Commerce and Labor, *Statistical Record of the Progress of the United States* (Oct. 1907) 7.

[11] In 1862 the Quartermaster General reported the army's consumption of clothing "beyond all allowance fixed by regulations from the experience of the Regular Army in time of Peace"—*Rebellion Records*, Ser. III, vol. II, 804; *cf. id.* 733.

[12] *Ex. Doc.* No. 1, 39th Cong., 1st sess: Report of Secretary of War, 42, 94.

[13] *Scientific American*, VI, 393, June 21, 1862.

This was the culmination of a tendency that had been growing ever since the beginning of the canal period, forty years before; and it increased the demand for rolling stock and fresh-water cargo boats.[14] High prices for farm produce at home and abroad encouraged the settlement of western lands, adding new territory to the domestic market with each season, while the scarcity of labor everywhere multiplied the call for farm machinery. Still further toward the setting sun prospectors and frontiersmen were developing a new empire, even in this period of national stress; and the recently discovered mines of the Rocky Mountains and the Pacific Coast were equipped by eastern foundries and machine shops. Simultaneously in the East the discovery of petroleum opened at a single stroke a new source of national and individual wealth and a new market for well supplies and containers. War manufacturing drew hands from the country to the towns and cities, where relatively more factory goods were consumed than upon the farms. The war tariff and the depreciation of the currency—with a corresponding rise of foreign exchange—aided by a patriotic desire to patronize home industries, erected a triple barrier against European competition.

Throughout the war northern manufacturers continued to ship goods abroad. Foreign markets had never taken an important share of their output and the fact that this trade continued throughout the period of hostilities is evidence mainly of its special character. Our exports of sewing machines, which were invented in this country and which our manufacturing system was peculiarly adapted to produce, rose rapidly. In 1864 we sent to foreign countries 50,000, valued at $2,000,000.[15] Refined petroleum became an important item in our trade with other lands.[16] There was very little shrinkage in the appraised value of our exports of iron and steel and their manufactures. The Baldwin works made locomotives for Brazil,[17] and our shipyards built frigates and merchant vessels for overseas governments and corporations.[18] Little if any falling off was recorded in our exports of boots and shoes, of other leather goods and of clothing. Naturally we did not hold our foreign markets for cotton goods, as the stout, heavy fabrics we sent abroad were the first to disappear from general trade when southern cotton failed our factory owners. We supplied the world market with even more lumber and timber than usual. In the midst of the war, California foundries were making sugar mills and steam engines for Mexico.[19]

[14] Fite, *Social and Industrial Conditions during the Civil War*, 42–46; cf. Channing, *History of the United States*, VI, 378–379.

[15] *Scientific American*, VI, 291, May 10, 1862; Fite, *Social and Industrial Conditions during the Civil War*, 90, Footnote.

[16] *Reports of a Commission appointed for a Revision of the Revenue System, 1865–1866*, pp. 243, 258–259.

[17] *Scientific American*, VII, 51, July 26, 1862.

[18] *Ericsson Papers*, Jan.–Apr. 1862; *Scientific American*, VIII, 19, Jan. 10, 1863; *id.*, VIII, 74, Jan. 31, 1863; *id.*, VIII, 282, May 2, 1863; *id.*, XI, 363, Dec. 3, 1864.

[19] *Scientific American*, VII, 70, Aug. 2, 1862; Defebaugh, *History of the Lumber Industry in America*, I, 533.

WAR LEGISLATION AFFECTING NORTHERN INDUSTRIES

War legislation, and especially the revenue laws enacted during this period, left a permanent impress upon certain industries; but in general this influence was of relatively minor importance compared with the vastly greater forces—both permanent and temporary—affecting our manufacturing development. The hostilities between the states did not, like the period of international disturbance which culminated in the War of 1812, create new forms of domestic industry or modify radically methods of production. None the less, they were the immediate occasion of a far-reaching change in the attitude of our Government toward manufacturing. We hardly need to recall that our second war with England was followed by a high-tariff era, whose rising tide of protection did not culminate until 1828. It is an interesting instance of those repetitions which so often occur in economic history, that the War of the Rebellion was like its predecessor in inaugurating a second cycle of high protection, which starting from purely fiscal motives expanded into an avowed attempt to shape by governmental means the forms of national production. The fact, that the secession of the South and its subsequent political impotence left the manufacturing states in control of federal policies, affected the subsequent organization, and what we might term the political history, of American industry. During the war itself high duties helped northern factory owners to control the domestic market in spite of heavy internal taxes. But the protective tariff policy then inaugurated was a post-bellum influence so far as it had permanent effect upon the growth of our manufactures.

The war tariffs were characterized by the substitution of specific and mixed specific and ad valorem duties for purely ad valorem duties, by a radical reduction in the free list, and by a marked increase in rates. Measured by their ratio to the total value of imports subject to tax, the duties collected by the Government rose from less than 20 per cent at the outbreak of the war to over 54 per cent at its close.[20]

Simultaneously heavy excise taxes were levied upon many goods manufactured within the country. In some industries their effect was to encourage the concentration of production in larger establishments. This was particularly true where successive processes in the manufacture of the same article or commodity might be performed either in several small shops or in a single factory. Since the tax was collected upon each maker's output, whether the latter was of finished goods or not, several taxes were paid where the work was distributed through a number of independent shops, while but one tax was paid where all stages of production occurred in a single establishment. So the machine builder who bought castings from an independent foundry had his costs increased by one additional tax over what they would have been had these parts been made in his own works.[21]

[20] *U. S. Ex. Doc.* 109, 42d Cong., 2d sess., 112.

[21] *Scientific American*, VII, 281, Nov. 1, 1862; Fite, *Social and Industrial Conditions during the Civil War*, 165–166.

Cloth spun, woven, dyed and finished in the same factory was taxed only once, while otherwise identical goods made where spinning, weaving and dyeing were done by independent establishments were taxed three times. The centralization of other industries, like distilling, was encouraged because speculation anticipatory to higher taxes attracted large capital into this business.[22] The heavy excise upon alcohol curtailed its industrial use. Turpentine replaced it in varnishes, and its high cost checked the manufacture of enameled ware, where it was used to wet the paste before baking. The soaring price of whisky was accompanied by a corresponding rise in the cost of vinegar, which made it difficult to manufacture in competition with foreign producers such diverse articles as pickles and white lead.[23]

Such illustrations of the effect of war taxes upon manufacturing, however, are curious rather than important. Most industries accommodated themselves in a rough and ready way to the new imposts with which they were burdened, sheltered themselves from foreign competition behind tariff walls, and passed on their increased costs to consumers.

[22] *Cf.* Bogart and Thompson, *The Industrial State*, 407.
[23] U. S. Revenue Commission, *Report for 1865–1866*, 162–163.

CHAPTER III

METALLURGICAL AND ENGINEERING INDUSTRIES IN THE NORTH 1860–1865

RAW MATERIALS IN THE NORTH

Raw materials, like manufactured goods, were taxed heavily during the war, and the reduction in the free list, together with the rise in foreign exchange, made our factory owners more dependent than ever upon domestic resources. Copper was procured in growing quantities from Michigan and California.[1] We still imported some ores from Chile, chiefly for mixing with those of native origin, but these foreign supplies were about balanced by the California ores that we exported. Missouri and Wisconsin continued to furnish a fair part of the lead we used. The expansion of the iron and steel industry to meet the demands of war was not checked by lack of materials. Between 1860 and 1864 the shipments of Lake Superior ore to lower Lake ports more than doubled.[2] A temporary shortage of coal occurred in the East, and there was some talk of converting locomotives into wood burners, but our manufacturers never suffered seriously from want of fuel. Western coal, especially from the Illinois fields, was coming into the market around St. Louis and Chicago, and began to attract industries to these vicinities.[3]

During the uncertain months before the South seceded, New England manufacturers acquired large stocks of cotton.[4] These supplies, with some foreign importations, with cotton procured from southern territories occupied by northern troops or shipped through the hostile lines by Confederates,[5] and with the crop of the border states—including a small quantity raised immediately north of the Ohio—kept our spindles partly employed throughout the war. The cultivation of flax extended somewhat and our wool clip about doubled. For a short time paper stock was wanting; but a rise in the price of rags drew out such a large supply that speculators in these materials lost money.

[1] *Commercial and Financial Chronicle*, VII, 135, Aug. 1, 1868; *Hunt's Merchants' Magazine*, XLIX, 470, Dec. 1863.
[2] *Hunt's Merchants' Magazine*, LIII, 413–414, Dec. 1863–4.
[3] *Scientific American*, II, 235, Apr. 7, 1860.
[4] U. S. Revenue Commission, *Report, 1865–1866*, p. 76.
[5] *E.g.* See Banks' letters to Lincoln and Seward, Feb. 2, 1864 and May 4, 1863, respectively: *Rebellion Records*, Ser. III, vol. IV, 69, and III, 188.

PRIMARY IRON MANUFACTURE

Less pig iron was made in the northern states in 1861 and 1862 than had been produced by all the states in 1860; but during the following two years the output was larger than ever before, though not greater, probably, than it would have been had peace continued.[6] The war affected the technical progress and the organization of the metal working and engineering industries more than it did the volume of their production, because the direct demands for ordnance and other military uses did not counterbalance the checked market for structural iron and railway equipment. Fort Pitt Foundry, the largest ordnance furnishers for the Government, made less than 3,000 tons of cannon and shots and shells a year during the war.[7]

Iron-making extended rapidly at the meeting point of Lake Superior ore and Pennsylvania and Ohio coal and coke. During the decade ending with 1865 the number of furnaces in the Mahoning Valley increased from 10 to 55, and their annual product from 20,000 to 216,000 tons. Thirty-two of these furnaces used Lake Superior ore exclusively, while the others mixed this with local ores.[8] As early as 1863 at least one Pittsburgh furnace was using Lake Superior ore entirely, and others were in course of erection which would do the same. This was when iron-jacketed furnaces first came into use in America.[9] Cleveland did not have a single furnace, forge or foundry in 1860; six years later it had 21 such establishments, employing 3,000 men and turning out 60,000 tons of manufactured iron a year.[10] Buffalo, where the industry was longer established, increased its furnace capacity.[11] The manufacture of charcoal iron in northern Michigan, which started shortly before the war, expanded moderately. Furnaces in that region were managed and operated like those of New England.[12] Upon the whole, the Lake Superior mines exercised an observable influence upon the geography of American iron-making during this period, though this was not directly due to the war.

West of the Mississippi there were 6 charcoal furnaces in Missouri, near the Pilot Knob and Iron Mountain mines. These were managed and operated after the manner of the charcoal furnaces south of the Ohio and Potomac.[13] Late in the war a furnace using Missouri ores and mineral coal from the neighboring Illinois fields was built at Carondolet, 6 miles south of St. Louis, which later became an iron manufacturing center of some importance. Missouri ores, like Lake Superior ores, were shipped to

[6] Department of Commerce and Labor, *Statistical Record of the Progress of the United States, 1800–1907*, p. 29; Special Commissioner of Revenue, *Report for 1868*, p. 3.

[7] *Scientific American*, VI, 163, Mar. 15, 1862; *id.*, XI, 165, Sept. 10, 1864.

[8] *Scientific American*, XV, 64, July 28, 1866; *Commercial Bulletin*, July 7, 1866; *Hunt's Merchants' Magazine*, LIV, 475–476, June 1866.

[9] *Scientific American*, VIII, 343, May 30, 1863.

[10] *Scientific American*, XV, 64, July 28, 1866.

[11] *Scientific American*, IX, 386, Dec. 19, 1863.

[12] *Hunt's Merchants' Magazine*, LIII, 415–416, Dec. 1865.

[13] *Hunt's Merchants' Magazine*, LIII, 333, Nov. 1865.

Pittsburgh; but the cost and uncertainty of transportation prevented this trade from becoming important.[14]

Most of the iron made in the North, however, came from the old furnace regions of the East, especially Pennsylvania. Here the war had little influence, except to maintain a firm market for the product and to encourage a steady but not phenomenal increase of output.[15] The tendency of military demand seems to have been to centralize rather than to disperse this industry. The Cambria Works, at Johnstown, were probably the largest in the country. They made 20,000 tons of pig a year, which they converted in their own mills into rails and other standard shapes.[16] In 1862 the Bethlehem Iron Works were completed, an incident destined to be of more future interest than immediate importance in the history of this industry.[17] When a furnace of the Lackawanna Iron and Coal Company, at Scranton, made 375½ tons of iron in a single week, it was accounted a record achievement for America.[18]

THE MANUFACTURE OF ORDNANCE

Foundry practice, iron rolling and steel making were more directly affected by the war than was total output. Army and navy requirements encouraged producing metal of higher and more uniform quality than hitherto, handling it in larger masses and working it to more exact dimensions.

Most of the heavy ordnance used by the Federal forces was of cast iron and was made in America. Fort Pitt Foundry, at Pittsburgh, which had cast cannon for the United States since 1803, was the principal producer of large caliber artillery. During the first three years of the war it delivered to the Government more than 2,000 heavy pieces, ranging from 8 to 20 inches in bore, and throwing 50 to 1,000 pound shot. The largest of these guns weighed when finished more than 50 tons.[19] Nearly all pieces of the larger sizes were smooth-bore muzzle-loaders, such as may still be seen performing ornamental service around our older coast defenses.

In 1849, Lieutenant Thomas Jefferson Rodman devised and successfully applied at Fort Pitt Foundry a process for casting large cannon hollow, instead of in solid blocks to be bored subsequently, as had previously been the practice. This was accomplished by circulating a stream of cold water through the interior of the core while the mass was cooling.[20] That still comparatively novel process was employed successfully throughout the war, and was used in making most of the heavy smooth-bores, or Columbiads,

[14] *Hunt's Merchants' Magazine*, LIII, 332, Nov. 1865.
[15] *Hunt's Merchants' Magazine*, XLIX, 239, Sept. 1863; American Iron and Steel Association, *Bulletin*, II, 106, Dec. 11, 1867, *id.*, IV, 314, June 8, 1870; Fite, *Social and Industrial Conditions during the Civil War*, 93, Note 1.
[16] *Scientific American*, xi, 374, Dec. 10, 1864.
[17] *Scientific American*, VI, 131, Mar. 1, 1862.
[18] *Scientific American*, VI, 170, Mar. 15, 1862; VI, 208, Mar. 29, 1862.
[19] *Scientific American*, XI, 165, Sept. 10, 1864.
[20] Bishop, *History of American Manufactures*, III, 98.

so famous at that time. To produce pieces of these dimensions required what were then considered very large casting and machining facilities. Several furnaces were tapped for each mold, and the lathe used for finishing big guns at Fort Pitt Foundry weighed more than 100 tons.[21]

A second type of cannon, invented by Captain Robert Parker Parrott and named after him, was patented in 1861. It was a built up piece, consisting of an iron tube, either cast solid and subsequently bored through from rear to muzzle, or else cast hollow by the Rodman process, over which was shrunk a wrought iron band at the point of greatest tension. A solid screw breech lock completed the essential elements of its construction. These guns were rifled and used oblong shot.[22] The Cold Springs Foundry, at West Point, New York, of which Captain Parrott, a former United States ordinance officer, was president, supplied the Government during hostilities with several hundred of these pieces of the largest caliber.[23] When the war began, the gun foundries at Pittsburgh and Cold Springs, and one at South Boston, were the only works in America that were prepared to turn out heavy artillery; but competitors soon appeared at Portland, Providence and Reading.

Wrought iron, bronze and brass were employed in making lighter artillery; and a few large-caliber cannon of wrought iron were manufactured experimentally. John Ericsson tried wrought iron smooth bores for some of his Monitors.[24] Late in the war the Ames Manfacturing Company, one of the best-known bronze founding and machine building firms in the United States, made on speculation several large rifled cannon of the same material. They were highly recommended in a report of a Committee on Heavy Ordnance published in 1865; but several subsequently burst under trial on account of defective welding and they were never used in actual service.[25] Light rifled guns forged from what is described as "puddled steel" or "semi-steel," were made by Corning, Winslow and Company, at Albany, in 1861, and by the Putnam Machine Company, at Fitchburg, the following year.[26] According to a contemporary newspaper a battery of six cast-steel guns was made at Pittsburgh, by Singer, Merrick and Company, early in the war, at the order of General Fremont, but apparently these guns were not accepted by the Government.[27] Krupps had been making cast-steel cannon in Europe since 1851; but they played no part on either side in the War.[28]

[21] *Scientific American*, x, 129–130, Feb. 27, 1864.

[22] *Scientific American*, ix, 233, Oct. 10, 1863.

[23] *Scientific American*, vi, 107, Feb. 15, 1862; Bishop, *History of American Manufactures*, iii, 178–181.

[24] *Scientific American*, x, 234, Apr. 9, 1864.

[25] *Ex. Doc.* 1, 39th Cong., 1st sess., 995; *Rebellion Records*, Ser. iii, ii, 38–39; iv, 469; v, 141–142.

[26] *Scientific American*, iv, 405, June 29, 1861; v, 26, July 13, 1861; v, 149, Sept. 7, 1861; vi, 6, Jan. 4, 1862; *cf.* Bishop, *History of American Manufactures*, iii, 217.

[27] *Scientific American*, vi, 227, Apr. 12, 1862; *cf. id.*, ix, 43, July 18, 1863.

[28] *Scientific American*, xii, 135, Feb. 25, 1865; *Report of the Secretary of the Navy, 1865* (Reports of Chiefs of Bureaus, 177); *Rebellion Records*, Ser. iii, iv, 469.

MANUFACTURE OF ARMOR

During the decade before the war our rolling mills, nearly all of which were north of Mason and Dixon's line, were employed increasingly in making rails, which branch of manufacture was becoming a separate business. Secession checked railway construction and curtailed the demand for railway iron; so that the rolling mill capacity of the North was more than adequate for the call made upon it by the army and navy. The latter was our largest iron consumer. Within nine months, according to a letter written by John Ericsson in the spring of 1863, the contractors of the monitor fleet alone had been supplied by American makers with 25,000 tons of wrought iron, rolled or forged into special shapes.[29] This was more than eight times the weight of the cast-iron ordnance produced by our largest cannon foundry during the entire war.

Our rolling-mill machinery was inferior to that employed in Great Britain and Europe, and at no time during hostilities were we prepared to make heavy armor plates in this country. In 1863, when 20-ton plates 12 inches thick were being rolled at Sheffield for the British admiralty,[30] our best mills—those of Abbott Brothers near Baltimore—could not roll armor more than 1.5 inches thick, and were obliged to trim even plates of that dimension with a planer instead of shears.[31] Two years later American 5-inch plates, either rolled or forged, were tendered our naval contractors, the rolled plates costing nearly one-half more than those shaped under the hammer.[32] All the plank-like armor of the Confederate rams and ironclads was forged.

The armor of the monitors was built up of plates about an inch in thickness, planed upon their edges, heated and bent to shape, punched for bolts and the bolt holes drilled to true diameter after the plates were in place.[33] Ericsson defended this method of construction as better than solid armor, and considered 6 inches of such laminated plating, backed by a layer of 5-inch wrought iron slabs and 4 inches of oak, impregnable for the artillery of the day.[34] This was the armor used on his later monitors. But European experiments, and American experiments with imported French plates, showed that solid armor was superior.[35] Since the North was fighting an enemy whose naval strength and artillery were inferior to its own, there was no imperative reason for protecting our ironclads—urgently needed as they were—with imported armor, or with domestic armor which

[29] *Ericsson Papers*, Letter of John Ericsson to Mayor George Opdyke of New York, Mar. 9, 1863.

[30] *Scientific American*, VIII, 306, May 16, 1863.

[31] *Ericsson Papers*, H. Abbott and Sons to John Ericsson, Mar. 31, 1863; *cf.* however, *Scientific American*, VI, 281, May 3, 1862.

[32] *Ericsson Papers*, Letter of William Wallace to John Ericsson, Nov. 1, 1865; *cf. Scientific American*, X, 121, Feb. 20, 1864.

[33] *Scientific American*, VII, 298, Nov. 8, 1862.

[34] *Scientific American*, X, 197, Mar. 26, 1864.

[35] See Report of Practice at French Iron Plated Target, Pencote Battery, Feb. 10, 1864, in *Ericsson Papers: cf.* a letter from J. F. Winston to John Ericsson, dated Troy, June 28, 1862, et passim in *Ericsson Papers; Atlantic Monthly*, XI, 86, Jan. 1863.

could be delivered only after a long delay. For the same reason we clung to cast-iron ordnance, which our superior charcoal iron enabled us to manufacture of high quality. As long as thin plates served the purpose, our rolling mills, with the civilian market which required mainly such plates always in view, acquired but tardily machinery of heavier capacity. Indeed, mechanical improvements even at this time were directed chiefly to producing plates of larger area and to saving labor in the process of rolling.[36] The war might end at any moment, but shipbuilders and boiler makers we should have ever with us. So while Government requirements did perhaps control rolling-mill development during the war, the progress thus encouraged was nevertheless directed toward ultimate civilian needs. Many new mills were erected and old ones enlarged, and we rolled more iron than ever before in our history. A greater variety of shapes was made by this process than hitherto, and rolled iron was used where castings or forgings had previously been employed.

Early in the war practically all the iron we used for making gun barrels, and most of the steel employed for making swords and bayonets, came from Great Britain. By 1863, however, Ringwood iron from New Jersey was used exclusively for rifle barrels at Springfield armory.[37] The Secretary of War reported that year:

> "Iron of a quality fully equal to the celebrated iron manufactured in England and Norway is now produced in ample quantity to meet our present wants . . . thus relieving us entirely of our former dependence on European producers."[38]

STEEL

While we did not become equally independent of foreign steel, great progress was made in the production of this metal. The Bessemer process was already successfully used in Great Britain and Europe, but was not introduced into America—partly on account of conflicting patents—until just at the close of hostilities. As early as 1863 the Assistant Secretary of the Navy, who was in immediate charge of arrangements for new war vessels, urged in a letter to John Ericsson that Bessemer works be erected immediately in this country;[39] and two years later the monitor builders produced at Albany the first steel made in America under the Bessemer patent.[40] The same works had previously attempted with some success to

[36] *Ericsson Papers*, Letter, Harvey K. Flagler to John Ericsson, Feb. 6, 1864; *cf. Hunt's Merchants' Magazine*, XLIX, 240, Sept. 1863; *Scientific American*, X, 200, Mar. 26, 1864; X, 405, June 25, 1864; XII, 168, Mar. 16, 1865; XIV, 180, Mar. 17, 1866.

[37] American Iron and Steel Association, *Bulletins*, XXII, 14, p. 109, Apr. 4, 1888; *Scientific American*, VIII, 198, Mar. 28, 1863.

[38] *Ex. Doc.* 1, 38 Cong., 1st sess., 11, 104; *Rebellion Records*, Ser. III, vols. II, 532–533; III, 12, 933.

[39] *Ericsson Papers*, Letter G. V. Fox to John Ericsson, Feb. 28, 1863.

[40] Bessemer steel had been made at Wyandotte, Michigan, but not under this patent, in 1864; *cf.* American Institute of Mining Engineers, *Transactions*, V, 201–214; *cf.* also *Ericsson Papers*, circular of Winslow, Griswold, and Holly dated Apr. 15, 1865: "Having commenced to manufacture cast steel under the Bessemer patents," etc.

improve upon an older process of making soft steel in puddling furnaces.[41] The real progress of the war period, however, was in the crucible steel industry. Its center was at Pittsburgh, but works were also started at Jersey City and in New England.[42] By 1864 the largest establishment in the country, that of Hussey, Wells and Company, at Pittsburgh, operated 120 melting furnaces, having extended its plant to ten times its capacity five years before, or 20 tons a day. These works supplied the steel used for sword and saber blades by the Ames Manufacturing Company, which was then our largest manufacturer of side arms.[43]

The military market was not the sole cause of this expansion. Civilian demands were growing in both volume and variety. They ranged from mower teeth to locomotive springs; and mining development in the Far West and northern Michigan caused an unexampled call for drills. In 1865, on the eve of the great growth of output which followed the introduction of the Bessemer process and the substitution of steel rails for those of iron, the United States produced 15,862 tons of steel, two-thirds of which came from Pennsylvania.[44] Tungsten steel and other alloys were already made in Germany, but their day had not yet dawned in America.

Another effect of the war upon iron and steel manufacturing, and upon the engineering industries in general, was to set higher standards of precision than had hitherto prevailed. A variation of one-hundredth of an inch in the bore of the 15 and 20-inch guns cast at Fort Pitt Foundry caused their rejection; and only one piece of the many ordered by the Government failed to meet this requirement.[45] Nevertheless the Chief of Ordnance, in his report for 1864–1865 mentions, "the greater accuracy of the manufacture," and "the more uniform and better quality" of arms and other ordnance stores made in Government armories, as compared with those furnished by private manufacturers.[46]

SMALL ARMS AND MUNITIONS

At the outbreak of the war the Federal Government had only two armories equipped to manufacture small arms. One of these, at Harper's Ferry, was immediately stripped of its machinery by Virginia state troops. The other, which was at Springfield, Massachusetts, had never turned out more than 800 muskets a month.[47] In addition several private establishments either were already making arms or afforded centers around which their manufacture could speedily develop. At Hartford was Colt's armory,

[41] *Scientific American*, v, 278, Nov. 2, 1861.

[42] *Scientific American*, x, 327, May 21, 1864; Swank, *Iron in All Ages*, 391–393.

[43] *Boston Commercial Bulletin*, Oct. 8, 1864; Bishop, *History of American Manufacturers*, III, 106.

[44] *De Bow's Review*, II, 362, 1865; cf. U. S. Revenue Commission, *Report, 1865–1866*, p. 341.

[45] *Scientific American*, XI, 165, Sept. 10, 1864.

[46] *Ex. Doc.* 83, 38th Cong., 2d sess., 114.

[47] *Ex. Doc.*, 37th Congr., 2d sess., Report of the Secretary of War, 7; *Scientific American*, v, 53, July 27, 1861.

rated the finest private plant of the kind in the world. The Sharps Rifle Works were in the same city.[48] At Ilion, New York, the Remingtons had been making rifles for forty years.[49] The Burnside Factory was just ready to open at Providence.[50] During the war these and other private establishments greatly increased their capacity. Some textile machinery manufacturers, finding the market for spindles dull during the cotton famine, turned to making rifles. The Amoskeag Company added to its machine shop one of the most complete armories in the country; and Alfred Jenks & Co., of Bridesburg, near Philadelphia, erected in connection with their existing plant, which had been making spinning machinery for half a century, an arms factory reported to be the largest private enterprise of the kind in America.[51]

The year of greatest development in the manufacture of small arms seems to have been 1863, when the North at length became thoroughly convinced that a serious and protracted struggle would be necessary to restore the Union. That year the Chief of Ordnance reported, "As regards small arms we may now regard ourselves perfectly independent of foreign aid."[52] Meanwhile the Government rapidly extended its own facilities. By the autumn of 1863 the Springfield Armory had increased its monthly output to more than 25,000 stand of arms;[53] and at the close of the war the Government owned 28 permanent arsenals and armories. Fifteen extensive private factories, in New England, New York, New Jersey and Pennsylvania were also manufacturing small arms for the army and navy at the rate of 60,000 stand a month; and 50 other works were engaged in making parts.[54]

There was a brief period early in the war when both the Federal and State Governments imported muskets from Europe.[55] But even before 1863, the North was able to equip its armies at home. At this date public and private works together were capable of producing well toward a million rifles, carbines, and revolvers annually.[56] Breech loaders were manufactured in 1861,[57] but it was not until the last year of hostilities that the War Department began to place large orders for these weapons.[58] Two of the

[48] Bishop, *History of American Manufactures*, III, 327–337; *Scientific American*, III, 311, Nov. 10, 1860; V, 40, July 20, 1861; T. W. Roe, *English and American Tool Builders*, 167–168.

[49] Bishop, *History of American Manufactures*, III, 226–227.

[50] *Scientific American*, IX, 243, Oct. 17, 1863.

[51] *Scientific American*, VI, 407, June 28, 1862; VII, 148, Sept. 6, 1862; IX, 34, *July 18, 1863;* National Association of Wool Manufacturers, *Bulletin*, IX, 1, 55–56; Bishop, *History of American Manufactures*, III, 24.

[52] *Ex. Doc.* 1, 38th Cong., 1st sess., 104; *Rebellion Records*, Ser. III, vol. III, 933.

[53] *Scientific American*, X, 162, Mar. 12, 1864; *Ex. Doc.* 83, 38th Cong., 2d sess., 114.

[54] *Ex. Doc.* 1, 39th Cong., 1st sess., 987; *Atlantic Monthly*, XII, 436–451, Oct. 1863.

[55] *Cf. Scientific American*, IV, 339, June 1, 1861; *Ex. Doc. 11*, 37th Cong., 2d sess., Report of the Secretary of War, p. 7. The total number of small arms bought abroad up to June 30, 1862—practically the total importations during the war—was 726,705: *Rebellion Records*, Series III, vol. II, 855.

[56] *Ex. Doc.* 1, 38th Cong., 1st sess., 104.

[57] *Scientific American*, IV, 371, June 15, 1861; V, 178, Sept. 21, 1861; *Rebellion Records*, Series III, vol. I, 423, 733–734.

[58] *Ex. Doc.* 83, 38th Cong., 2d sess., 115; *Rebellion Records*, Ser. III, vol. IV, 593–594, 802; Manchester, *Story of Silk and Cheney Silks*, 41.

leading models, the Spencer carbine and the Peabody rifle, were made at Providence.[59] In his report for 1866 the Secretary of War said:

"From January 1, 1861, to June 30, 1866, the Ordnance Department provided 7, 892 cannon, 11,787 artillery carriages, 4,022,130 small arms, 2,362,546 complete sets of accouterments for infantry and cavalry, 28,164 sets of horse artillery harness, 1,022,176,474 cartridges for small arms, 1,220,555,435 percussion caps, 2,862,177 rounds of fixed artillery ammunition, 14,507,682 cannon primers and fuses, 12,875,294 pounds of artillery projectiles, 26,440,054 pounds of gunpowder, 6,395,152 pounds of niter, and 90,416,295 pounds of lead, in addition to immense quantities of extra parts used for repairing and replacements."[60]

ENGINEERING AND METAL-WORKING INDUSTRIES

Naturally this expansion of arms manufacturing was temporary. As soon as peace returned most private armories were converted to other uses. Some took up the manufacture of locomotives; others resumed making textile machinery. But the influence of this period of intensive metal working in a field where automatic machinery, precision-gages, and interchangeable parts were employed, continued to be felt in our subsequent shop development. During this period Pratt & Whitney got their start, and other American machine-tool builders extended their market and perfected their product.

A simultaneous call for machinery to replace the labor drafted into the army also stimulated the metal-working trades.[61] During the decade preceding 1860, the manufacture of sewing machines, which were an American invention, had been well established, and the market for them was already growing rapidly.[62] But war demands hastened their introduction in factories making clothing and boots and shoes.[63] Even during hostilities, American manufacturers supplied both the domestic and the foreign market. The war had a similar effect upon the manufacture of farm machinery. Harvesters and mowers and other aids to human labor in agriculture had already been perfected and were being manufactured in some quantities before hostilities began.[64] But the simultaneous enrolment of a large fraction of the young manhood of the country in the army, and extension of the cultivated area into the virgin prairie lands of the upper Mississippi valley and farther west, created an urgent demand for labor-saving devices upon the farm, and the output of agricultural machinery increased with unprecedented rapidity during these four years.[65] Indeed, the use of

[59] *Scientific American*, XI, 281, Oct. 29, 1864; *cf.* also *id.*, XI, 89, Aug. 6, 1864; XIV, 48, Jan. 20, 1866.
[60] *Rebellion Records*, Ser. III, vol. V, 1042–1043.
[61] *Scientific American*, VI, 378, June 14, 1862.
[62] *Scientific American*, VI, 291, May 10, 1862.
[63] Fite, *Social and Industrial Conditions during the Civil War*, 89–92; Hazard, *Organization of the Boot and Shoe Industry in Massachusetts, before 1875*, 124. But the change had begun before 1860: *Cf. Scientific American*, III, 195, Sept. 22, 1860; 230, Oct. 6, 1860.
[64] McCormick sold some 4,000 reapers the year before hostilities began: *Scientific American*, III, 137, Aug. 25, 1860; *cf. id.*, II, 75, Jan. 28, 1860.
[65] *Cf. Scientific American*, X, 386, June 18, 1864.

harvesting machinery, by making it possible for the North to maintain, and even to increase, its exports of agricultural products to Europe, contributed largely to the nation's ability to carry the economic burden of the war.[66] During the second year of hostilities 240 patents were issued for improvements in firearms and other military devices, and 490 patents were granted for agricultural implements.[67]

For a time after the outbreak of hostilities some engineering industries suffered. The manufacture of locomotives abruptly declined, but by 1862 orders began to come in again, and thereafter the shops were fully occupied.[68] The Baldwin Works, as we have already noted, built locomotives for Brazil;[69] but domestic demands increased so rapidly and the maintenance of good railway service was so important for both military and commercial reasons, that in 1864 the Federal Government forbade leading manufacturers to take further foreign orders.[70] At this time iron passenger coaches and freight cars came into occasional use on the eastern roads.[71] Many iron bridges were erected during the war years, including the great railway bridge, 1,890 feet long, across the Ohio River at Steubenville.[72]

Military requirements made heavier demands than had ever before existed upon the country's transportation system. After the Mississippi was closed a considerable portion of the traffic that had previously sought export markets through New Orleans was diverted directly to the Atlantic seaboard.[73] Less railway mileage was built annually than before the conflict began; for in 1860 the country had added 1,846 miles to the lines in operation, a quantity not equaled again until 1867. Yet even in the midst of hostilities about 800 miles per annum were built; and changes hastened by military needs, such as substituting a uniform gage for the different gages hitherto in use, created a steady demand for railway material.[74]

SHIPBUILDING

Shipbuilding also was active, not only on the coast but also on the Great Lakes and inland waterways. Our merchant marine had begun to decline before the war, for already iron steamers were displacing wooden sailing ships and Great Britain was reaping the advantage of the cheaper cost of steam vessels in that country.[75] Nevertheless, the shipbuilders of the

[66] Fite, *Social and Industrial Conditions during the Civil War*, 6–8; *Scientific American*, VII, 68, Aug. 2, 1862; IX, 9, July 4, 1863; *Hunt's Merchants' Magazine*, XLIX, 219–220, Sept. 1863; LI, 243, Sept. 1864; *cf.* also *Scientific American*, X, 359, June 4, 1864.

[67] National Association of Wool Manufacturers, *Bulletin*, IX, 57, Mar. 1879.

[68] *Scientific American*, VI, 6, Jan. 4, 1862; VII, 9, July 5, 1862.

[69] *Scientific American*, VII, 51, July 26, 1962.

[70] *Scientific American*, X, 227, Apr. 9, 1864. "Naturally a similar veto was placed on the exportation of artillery." Secretary Stanton to Secretary Seward, Jan. 27, 1863: *Rebellion Records*, Ser. III, vol. III, 21.

[71] *Scientific American*, IV, 231, Apr. 13, 1861; IX, 275, Oct. 31, 1863.

[72] *Scientific American*, IX, 354, Dec. 5, 1863; *cf.* also *id.*, IX, 99, Aug. 15, 1863; *Hunt's Merchants' Magazine*, XLV, 291, Sept. 1861; *Boston Commercial Bulletin*, Apr. 11, 1863.

[73] *Hunt's Merchants' Magazine*, LIII, 207, Sept. 1865; LIV, 83, Jan. 1866.

[74] *Commercial and Financial Chronicle*, XXII, 555, June 10, 1876; *cf. Scientific American*, VII, 19, July 12, 1862; X, 57, Jan. 23, 1864.

[75] *Scientific American*, II, 180, Mar. 17, 1860; II, 217, Mar. 31, 1860.

Atlantic coast were prosperous and were still confident that they would eventually be able to compete successfully with their British rivals.[76] In 1861, Harlan, Hollingsworth and Company, of Wilmington, wrote:

> "Iron shipbuilding steadily increases; we have built 73 iron hulls large and small. A first-class iron hull costs no more than a wooden hull coppered. We now use American iron altogether, it being the best iron manufactured."[77]

Merchant shipbuilding was encouraged both by the Government's withdrawal of a large amount of tonnage from ordinary commerce for employment in its transportation and supply service and by heavy shipments of provisions abroad. It was estimated that in 1861 well over 500 average-size vessels were required to carry the increased quantities of grain and live stock delivered to Europe over the amount delivered in 1860.[78] Even in the midst of hostilities American shipyards built steamers for foreign owners, especially boats to ply upon the rivers of China.[79] Maine shipyards were unusually busy.

Naturally, however, naval demands were paramount. When hostilities began the North had about two dozen machine shops, great and small, distributed from Maine to Maryland, which might in an emergency make marine machinery. The first-class shops did not exceed eight in number.[80] For a time there was a scarcity of raw materials. When the Government contracted for 23 new gunboats in 1861, the orders for hulls were placed with 23 different shipyards, and for marine engines with 12 different machine shops.[81] According to contemporary accounts there were not sufficient raw materials in the country for the large and sudden demand which the Navy's orders made upon shipbuilders. Inexperienced labor was necessarily employed; the price of machinery rose immediately; and the pay of mechanics and the cost of materials reached an abnormal height. These conditions naturally resulted in delayed deliveries, poor workmanship, and defective machinery; but they were speedily remedied, and by 1862 and 1863 the larger works in the vicinity of New York, Philadelphia and Boston were able not only to fill all orders for our own Government, but also to accept orders for ironclads from abroad. Indeed the development of shipbuilding facilities during the war accounts in part for the later activity of this industry, especially on the Delaware. At this time two steam frigates were built in New York for Italy,[82] and John Ericsson figured upon two monitors for the Peruvian government.[83]

[76] *Scientific American*, v, 395, Dec. 21, 1861; vi, 11, Jan. 4, 1862; viii, 144, Feb. 21, 1863.
[77] *Scientific American*, iv, 275, May 4, 1861; *Hunt's Merchants' Magazine*, xliv, 606, May, 1861.
[78] *Scientific American*, v, 171, Sept. 14, 1861.
[79] *Scientific American*, viii, 19, Jan. 10, 1863; x, 243, Apr. 16, 1864; xi, 363, Dec. 3, 1864.
[80] *Scientific American*, xi, 306, Nov. 12, 1864.
[81] *Scientific American*, v, 39, July 20, 1861.
[82] *Ericsson Papers:* Letter of W. E. Everett to Ericsson, Apr. 29, 1862; *Scientific American*, viii, 74, Jan. 31, 1863; viii, 282, May 2, 1863; Tenth Census, *Reports*, viii (Ship-building Industry), 197, 201.
[83] *Ericsson Papers:* Ericsson to Captain Amana G. Firson, May 24, 1862; John B. Kitching to Ericsson, May 28, 1862; Ericsson to Messrs. Barreda and Company, May 29, 1862, and their reply of May 30, 1862.

Compound engines were not used in either naval or merchant vessels at this time. But the problem of providing cruisers fast enough to catch the speediest blockade runners, and able to operate with the utmost economy of fuel, led to the introduction of the forced draft and to improvements in the simple engine that raised it to a much higher point of efficiency than before. The latter accomplishment was largely due to the painstaking experiments of Chief Engineer B. F. Isherwood, of the United States Navy. A Federal cruiser, the *Wampanoag*, launched just after the close of the war, averaged 16.7 knots an hour during a 37-hour test in winter seas off Cape Hatteras, a record reported to exceed by 4 knots an hour that of any other vessel then afloat.[84]

In 1863 the first tank steamers were loaded with crude petroleum at Philadelphia, and about the same time the earliest pipe lines were laid for transporting oil from the wells in western Pennsylvania to the railroads.[85] All mineral industries were stimulated by the war. The output of copper in the Lake Superior region rose from 6,000 to 8,000 tons per annum; California shipped 10,000 tons a year to eastern smelters; and Cuban and South American ores were reduced at Baltimore. Since the United States even during hostilities consumed only 12,000 tons of copper a year, the country had a considerable excess to export.[86]

[84] *Engineering Magazine*, XXII, 834–846, Mar. 1902; *Report of the Secretary of the Navy*, 1865–1866, Reports of Chiefs of Bureau, 307.

[85] *Scientific American*, IX, 83, Aug. 7, 1863; XI, 118, Aug. 20, 1864.

[86] *Commercial and Financial Chronicle*, VII, 135, Aug. 1, 1868. The war caused wide price fluctuations and important improvements in mining methods. *Hunt's Merchants' Magazine*, XLVI, 379, Apr. 1862; XLIX, 470, Dec. 1863; *Scientific American*, III, 162, Sept. 8, 1860; VI, 38, Jan. 18, 1862; VI, 232, Apr. 12, 1862; VIII, 39, Jan. 17, 1863; Fite, *Social and Industrial Conditions during the Civil War*, 25.

CHAPTER IV

TEXTILE AND GENERAL MANUFACTURING IN THE NORTH 1860–1861

COTTON SUPPLY

During the years immediately preceding the war, cotton manufacturers in both the United States and Great Britain were very prosperous and a rapid expansion of the industry occurred. By 1860, however, production was in excess of consumption.[1] England was rapidly adding to her spindles regardless of the fact that many mills were being erected on the Continent to supply a market that previously had been almost monopolized by British manufactures.

When the South seceded and the Federal navy blockaded its ports, the principal source of the world's cotton supply was suddenly eliminated. The ensuing cotton famine in Great Britain is one of the darkest chapters in that country's industrial history.[2] For several reasons a happier condition prevailed in the cotton manufacturing districts of the North. New England spinners had bought raw cotton heavily, perhaps because they had not foreseen the prospect of overproduction which was already intimidating their British rivals. Although our exports of cotton in 1860 were 100,000 bales below the average, the quantity taken by northern spinners during the first six months of the crop season immediately preceding hostilities exceeded previous records by 52,000 bales.[3] While the war resulted in a decrease of cotton consumption throughout the world from an average of nearly 2,000,000,000 pounds during the five-year period immediately before and after the war to about 1,250,000,000 pounds from 1861 to 1865, the decline in the United States was relatively even greater, or from about 360,000,000 pounds to 181,000,000 pounds per annum.[4] This enormous reduction was compensated in part by economics in the use of fabrics and by the larger employment of other spinning fibers.

In addition to the stock on hand, northern mills received American cotton from a variety of sources. Immediately before the war, southern shippers to northern spinners had routed their consignments increasingly via Ohio River ports instead of Gulf ports.[5] This was due to improved railroad

[1] Dana, *Cotton from Seed to Loom*, 242; *Hunt's Merchants' Magazine*, LI, 372, Nov. 1864.

[2] *Cf.* Scherer, *Cotton as a World Power*, 265–269; *Hunt's Merchants' Magazine*, XLIX, 359, Nov. 1863.

[3] *Hunt's Merchants' Magazine*, XLIV, 328, Mar. 1861; *cf.* United States Revenue Commission, *Report, 1865–1866*, 76.

[4] Dana, *Cotton from Seed to Loom*, 246–248.

[5] Between 1851 and 1861 overland shipments rose from 175 bales to 143,424 bales: *United States Commerce and Navigation Reports*, 1886, Part II, p. lxvii.

facilities. Furthermore compressors had come into use, so it was possible to load 30 bales on a car whereas only 20 bales could be carried previously. The result was that when the South seceded, a considerable quantity of cotton was distributed in transit or in storage along the route from the Ohio to New England.[6] This cotton, together with that in stock at the mills or in northern warehouses, was sufficient to keep the spindles of the country running for several months. Some factory owners sold their cotton and converted their mills to other uses, generally at an eventual loss.[7] Those who took the risk of purchasing cotton in the rapidly ascending market were able to keep their mills wholly or partly in operation, and made large profits by the rising value of their raw materials and manufactured goods.[8]

No data exist for estimating the actual supply of American cotton for 1861 and 1862. The reason American spinners had been induced to purchase heavily in 1861 was not so much their anticipation of secession, as because they expected an unusually short crop the following year. Consequently when the war broke out many mills had in stock enough cotton to keep them in operation through the latter emergency. By curtailing their production and manufacturing lighter fabrics, they made this heavy supply last nearly two years. In 1863 the amount of cotton available for northern mills was about 4,000 bales per week, of which 3,500 were American and 500 were Indian. This was approximately a quarter of the quantity required to keep the spindles of the country in full operation.[9] Some American cotton was accordingly re-imported from England, but most of that received came from the southern territory occupied by northern troops. As early as 1862 the Federals by obtaining possession of Port Royal secured about 400,000 pounds of Sea Island cotton.[10] After the capture of New Orleans, supplies were received through that port.[11] Cotton was also shipped down the Cumberland and Tennessee. A report from Nashville in 1862 stated that cotton buyers were scouring the country in all directions and that "the planters are acting like men of practical sense and are quick to trade."[12] In the spring of 1863, 14,000 bales of cotton passed through Cairo, Illinois, on their way to a northern market.[13] Considerable quantities were captured by the Federal armies during their occupation of southern territories.[14]

[6] *Scientific American*, IV, 167, Mar. 16, 1861; *Hunt's Merchants' Magazine*, XLIV, 782–783, June, 1861; XLVI, 391, Apr. 1862.

[7] Webber, *Manual of Power*, 64; Cowley, *History of Lowell*, 48, 61.

[8] E. g. *cf. Report on the Affairs of the Franklin Company, of Lewiston, Maine*, 1879, 16. (Found in *Economic History Pamphlets, United States, 1864–1902*, Harvard University Library.)

[9] United States Revenue Commission, *Report, 1865–1866*, 76.

[10] *Scientific American*, VI, 10, Jan. 4, 1862; VI, 34, Jan. 18, 1862; VI, 51, Jan. 25, 1862; VI, 228, Apr. 12, 1862.

[11] *Scientific American*, IX, 2, July 4, 1863; *cf. Rebellion Records*, Ser. III, vol. II, 382.

[12] *Scientific American*, VI, 299, May 10, 1862; *cf. Rebellion Records*, Ser. III, vol. III, 188; vol. IV. 69.

[13] *Scientific American*, VIII, 131, Feb. 28, 1863.

[14] *Ex. Doc.* 97, 39th Cong., 2d sess., *Captured and Forfeited Cotton*, 5.

Some cotton was raised in the North. In colonial times it had been regularly planted for domestic purposes on the eastern shore of Maryland and in southern Delaware. It had also been grown as a common crop in the Wabash Valley and throughout southern Indiana and Illinois until the extension of cotton planting into the southwest and improved transportation rendered this unprofitable. Therefore it was natural that its cultivation should be resumed when other sources of supply were curtailed.[15] Enthusiasts prophesied early in the war that southern Illinois would eventually produce 100,000 bales.[16] Frosts ruined the lowland cotton throughout the region in 1863, but cotton planted on the high ground produced a satisfactory yield.[17] In 1864 a farm in the vicinity of Peru, Illinois, had 260 acres under cotton, and several cotton gins were running in the vicinity.[18] A small quantity was raised in Utah and a mill was operated there.[19]

Cotton was also imported, either directly or via Great Britain, from India, China, and other cotton-producing countries, whose crops were rapidly increased to meet the demand left unsatisfied by the practical disappearance of southern cotton from the world market.[20] Meanwhile the high price of cotton induced manufacturers to adopt every process and device that promised to lessen waste, and to employ as much waste as possible in their yarns. "It is remarkable how well some of us succeeded; and this success during the high price of cotton strongly tempts us to continue working waste, even when the price of cotton becomes moderate," observed a veteran New England spinner a year after the conclusion of hostilities.[21]

Efforts were naturally made to find a substitute for cotton. For ten years or more before the war, experiments had been conducted in "cottonizing" flax, and in 1859 machinery had been sufficiently perfected so that "fibrilia," as the new product was called, began to be used commercially. It was mixed with cotton and with wool, and was used in making an artificial leather; but it never contributed largely to the nation's supply of textile material.[22]

The protracted scarcity of cotton naturally encouraged the substitution of woolens and linen for cotton fabrics. It was estimated that 72 per cent by weight of the textiles manufactured in Great Britain during the five years preceding the Civil War were cotton fabrics. During the five years following that event, this proportion had fallen to 63.5 per cent.

[15] Conkling, *On the Production and Consumption of Cotton*, 20–21.
[16] *Scientific American*, VII, 141, Aug. 30, 1862; *cf. id.*, V, 307, Nov. 16, 1861.
[17] *Scientific American*, X, 19, Jan. 9, 1864.
[18] *Scientific American*, XI, 356, Dec. 3, 1864; XII, 48, Jan. 21, 1865.
[19] *Scientific American*, IX, 404, Dec. 26, 1863.
[20] *Scientific American*, VI, 69, Feb. 1, 1862; VI, 107, Feb. 15, 1862; VII, 69, Aug. 2, 1862; New England Cotton Manufacturers' Association, *Proceedings of the Semi-annual Meeting, Boston, October 31, 1877*, pp. 35–36; *cf.* however, *Hunt's Merchants' Magazine*, XLVI, 382, Apr. 1862; Scherer, *Cotton as a World Power*, pp. 292–3.
[21] New England Cotton Manufacturers Association, *Statistics of Cotton Manufacturers in New England, 1866*, p. 10.
[22] Bishop, *History of American Manufactures*, III, 267.

COTTON MANUFACTURING

Manufacturers of heavy sheetings and other coarse goods suffered most from the war. Lowell, which was our leading cotton spinning city at that time and had always been a large producer of sheeting, drills and kindred fabrics, felt the effects of hostilities more severely, perhaps, than any other place in America; although this was possibly due as much to the miscalculations of manufacturers as to the inherent difficulties of the situation. In 1863 only 1,000 of its 12,000 looms were running.[23] In January 1864 there was not a cotton spindle in motion in the city.[24]

Rather oddly, however, several new factories were built and put into operation while hostilities were in progress.[25] In various parts of New England well over 100,000 spindles were added to mill capacity. Small mills were also erected in the West. Even the Lowell corporations, though deprived for the moment of the cotton manufacturing business, took advantage of this idle time to rebuild and enlarge their establishments. Some of these improvements were made in order to give employment to workmen, the manufacturers feeling that they must support their hands in any event and that they might as well get some return for so doing. Moreover, foresighted mill owners were preparing for the period of great activity, which they justly anticipated as soon as hostilities ceased and cotton could be obtained.[26]

Finer fabrics, especially print cloths, continued to be manufactured in considerable quantities. During 1862 the transactions in these at Providence amounted to nearly 4,000,000 pieces, an increase of more than 300,000 pieces over the year before.[27] Extensions to print works were occasionally reported.[28] In 1864 the Manchester Print Works, for instance, were "as usual, at full blast."[29] In April 1864 the Merrimac Company resumed printing after a cessation of two years.[30] By 1864 the Providence transactions in print cloths had fallen to about 2,700,000 pieces, but prices had risen to an extraordinary height. Cloth that had sold for less than five cents per yard before the war commanded 27 cents per yard five years later.[31] The manufacture of cotton thread was established in this country, partly because the unfavorable exchange with England made importation from that country abnormally expensive. Holt's English thread, which was the most popular brand in America, suddenly rose to four times its

[23] *Scientific American*, VIII, 146, Mar. 7, 1863; Cowley, *History of Lowell*, 48.
[24] *Scientific American*, X, 19, Jan. 9, 1864.
[25] Webber, *Manual of Power*, 64–65; *Bagnall Papers*, iii, 1945, 1947; *Scientific American*, VII, 115, Aug. 23, 1862; VII, 314, Nov. 15, 1862; VII, 146, Mar. 7, 1863; XI, 22, July 9, 1864.
[26] *Scientific American*, VI, 219, April 5, 1862; VII, 314, Nov. 15, 1862.
[27] *Scientific American*, X, 67, Jan. 30, 1864.
[28] *Scientific American*, VIII, 274, May 2, 1863.
[29] *Scientific American*, X, 162, Mar. 12, 1864.
[30] *Scientific American*, X, 243, Apr. 16, 1864.
[31] *Scientific American*, XII, 62, Jan. 21, 1865.

former price.[32] The manufacture of hosiery and other knit goods was encouraged by heavy demands from the army.

In 1863, after the effects of the cotton shortage were fully felt, it was estimated that about 1,700,000 of the 4,000,000 spindles in the North remained running. The curtailment had not caused distress among the operatives, as it did in England, because enlistments in the army and the great demand for mechanics in Government workshops gave employment to the men, while the increase of wool manufacturing and the activity of the other industries in which women were employed speedily absorbed the surplus female labor.[33]

Efforts were made to encourage the production of linen goods in America in the hope that they might at least partly supply the place of cotton. The manufacturers of Rhode Island offered, through their Society, prizes for the encouragement of domestic industry, including small sums of money for the best prepared flax and for the best flax linen manufactured. Linen bags were woven in northern New York, although Indian cotton was discovered to be a good fiber for this purpose.[34] Linen thread was also manufactured in America from both domestic and imported flax.[35] Little linen mills were erected at a few points in the West and there was some resumption of homespun manufacturing, which had not yet entirely disappeared from rural districts.[36]

WOOL MANUFACTURING

While the war caused a depression in the cotton industry, it produced the contrary effect upon wool manufacturing. Both the cotton shortage and army demands stimulated this branch of industry. Although the price of wool, at least in currency, rose sufficiently to encourage sheep raising and greatly to increase the domestic clip, some grades of wool were at times cheaper than cotton.[37]

Two of the greatest wool producing regions in the world, Australia and the Argentine, were rapidly adding to their production, and the constantly expanding supply from these sources tempered the tendency to boost prices in the United States.[38] Army cloth and blankets, for which there was a heavy immediate demand, were made largely of coarse wools, the price of which rose relatively faster than the price of fine wools.[39] The decreased supply and the rising cost of cotton fabrics favored the larger manufacture of worsteds, which had been established in America not long before the war.

[32] *Scientific American*, XI, 345, Nov. 26, 1864; XI, 370, Dec. 10, 1864; XIII, 257, Oct. 21, 1865.

[33] *Report of the Boston Board of Trade*, quoted in *Scientific American*, IX, 89, Aug. 8, 1863; S. Batchelder, *Cotton Manufacture*, 94–95.

[34] U. S. Flax and Hemp Commission, *Report*, 56; *Scientific American*, XII, 132, Feb. 25, 1865.

[35] *Cf. Scientific American*, XII, 55, Jan. 21, 1865.

[36] *Cf. Scientific American*, VII, 69, Aug. 2, 1862; also VI, 58, Jan. 25, 1862; U. S. Flax and Hemp Commission, *Report*, 96.

[37] *Cf.* however, Wright, *Wool-Growing and the Tariff*, 163.

[38] Wright, *Wool-Growing and the Tariff*, 165, 166; *Scientific American*, VII, 107, Aug. 16, 1862.

[39] *Scientific American*, V, 87, Aug. 10, 1861; VII, 69, Aug. 2, 1862.

Our reciprocity treaty with Canada enabled northern manufacturers to procure free of duty her excellent combing wools.[40]

The wool manufacture had always been widely distributed in America and, with one or two marked exceptions, it was conducted in smaller establishments than the manufacture of cotton.[41] A large number of little woolen mills sprang up in the country towns and villages of the West;[42] and a few were in operation on the Pacific coast, which produced, among other fabrics, "excellent army cloths and blankets."[43] Although there was never a wool shortage, the use of shoddy and other adulterants increased.[44] In common opinion they were used especially in goods manufactured under contract for the Government.[45]

The best measure we have for the expansion of the woolen industry during this period is the estimated increase in the consumption of raw wool. In 1860 our manufacturers used about 85,000,000 pounds per annum. During the war the military demand alone was estimated at 75,000,000 pounds a year, while the total quantity manufactured in the country rose to 200,000,000 pounds.[46] The number of sets of machinery increased within five years from about 3,000 to 5,000.

When the recruits began to pour in during the summer and autumn of 1861 the War Department was forced to order cloth for the army from Europe, though apparently to the value of less than $1,000,000. This provoked a prompt protest from the Boston Board of Trade, which declared that American mills had "incurred great expense in altering their machinery so as to execute the orders of the Government" and that cloth to clothe an army of half a million men could be made in the United States before it could be procured from England and Germany.[47] The Quartermaster General estimated that the quantity needed was nearly 4,000,000 yards and doubted the ability of domestic factories to produce this quantity, adding, "I fear that there is neither the wool nor the indigo in this country to make the cloth we need."[48] By the following year the preliminary shortage had been overcome, apparently through the expansion of domestic industry, although blankets and tents were still difficult to procure in adequate quantities—the latter on account of the scarcity and high price of cotton.[49]

[40] Wright, *Wool-Growing and the Tariff*, 174.

[41] *Cf.* for New England, *Scientific American*, x, 49, Jan. 23, 1864.

[42] *Scientific American*, xvi, 327, May 25, 1867.

[43] Hittell, *Commerce and Industry of the Pacific Coast*, 438; *Scientific American*, vi, 11, Jan. 4, 1862; ix, 66, Aug. 1, 1863; xiii, 352, Dec. 2, 1865; *Ex. Doc. 83*, 38th Cong., 2d sess. (Report of Secretary of War), 144.

[44] *Cf. Scientific American*, v, 228, Oct. 12, 1861; *Hunt's Merchants' Magazine*, xlv, 627, Dec. 1861; *Commercial and Financial Chronicle*, ii, 228, Feb. 24, 1866.

[45] This charge dated from the very beginning of the war. *Scientific American*, vi, 89, Feb. 8, 1862; *cf.* however, *Rebellion Records*, Series iii, vol. ii, 803.

[46] Fite, *Social and Industrial Conditions during the Civil War*, 84–85; *cf. Scientific American*, ix, 55, July 25, 1863; *Hunt's Merchants' Magazine*, liii, 471, 473, Dec. 1865; *Commercial and Financial Chronicle*, i, 391–392, Sept. 23, 1865; ii, 227–228, Feb. 24, 1866; Cole, *The American Wool Manufacture*, 378.

[47] *Rebellion Records*, Ser. iii, vol. i, 582–584.

[48] *Rebellion Records*, Ser. iii, vol. i, 609.

[49] *Rebellion Records*, Ser. iii, vol. ii, 371–373, 802–805; vol. v, 261–267.

In spite of the numerous small woolen mills which went into operation at this time, the total effect of the war was probably to concentrate this industry still further in what were already the more important wool manufacturing states.[50] The business was so profitable that it attracted large corporations into the industry. Some of the big Lowell factories changed from cotton to wool late in the war, not always with fortunate results.[51] On the other hand the Washington Mills at Lawrence sold nearly $4,000,000 worth of goods in 1863, upon which they netted a profit of $840,000, or about 50 per cent upon their capital.[52] As in the case of cotton manufactures, however, high profits in the woolen industry were partly due to the rise in the price of raw materials.[53] The manufacture of woolen knit goods was especially active.[54]

CLOTHING, FOOD AND DRINK

In the manufacture of clothing and of boots and shoes, both of which were naturally stimulated by Government purchases for the army and navy,[55] the notable feature of the war period was the introduction of the sewing machine.[56] This favored the production of both uniforms and boots and shoes in factories, which in turn encouraged the invention and adoption of other labor-saving devices. It was estimated that fully half the labor formerly employed in the manufacture of light clothing could be dispensed with by substituting machine sewing for hand sewing. According to a contemporary authority—

> "No men's sewed boots were produced in Massachusetts in 1860 except by custom workmen and by a half dozen manufacturers in Quincy and its vicinity, who made sewed calf boots for the Southern trade."[57]

A single army contract for 800,000 military bootees did much to encourage the substitution of sewed soles for the pegged soles formerly in use, and opened new fields for the sewing machine. Soles were already pegged by machinery. By the close of the war, machines were used to roll sole leather, which was formerly hammered; to split upper leather, which was formerly done by hand; to form the soles; to skive the stiffenings; to channel the soles, to stitch the upper leather and bind the edges, to sew the uppers

[50] *Cf.* Ninth Census, *Industry and Wealth*, Statistics of Manufactures, Table X, 630–633.
[51] Cowley, *History of Lowell*, 48, 51, 54, 55.
[52] *Scientific American*, X, 34, Jan. 16, 1864; *cf.* Fite, *Social and Industrial Conditions during the Civil War*, 84.
[53] National Association of Wool Manufacturers, *Bulletins*, II, 3, Jan. 1870; Cole, *The American Wool Manufacture*, 380–381.
[54] *Scientific American*, V, 384, Dec. 14, 1861; VII, 214, Oct. 4, 1862; VIII, 163, Mar. 14, 1863; XVI, 167, Mar. 16, 1867.
[55] *Cf. Ex. Doc.* No. 1, 39th Cong., 1st sess., p. 95.
[56] Fite, *Social and Industrial Conditions during the Civil War*, 89–90. The introduction of the sewing machine, however, slightly antedated the war. *Cf. Scientific American*, III, 195, Sept. 22, 1860; III, 230, Oct. 6, 1860. For the use of the sewing machine in the boot and shoe industry from 1852 to 1860, see Hazard, *The Organization of the Boot and Shoe Industry in Massachusetts before 1875*, 94, 95–96, 116–118.
[57] *Shoe and Leather Reporter* quoted in *Scientific American*, V, 304, Nov. 9, 1861.

to the sole, and to form and attach the heels—which multiplied the output per operative from five to ten times.[58] The country's principal shoe-manufacturing center was in eastern Massachusetts, but shoe factories of some size were erected about this time in Chicago, Cincinnati and San Francisco.[59] Saddlery and knapsacks, for which the war created a large additional demand, were mostly made in New York, Newark, Philadelphia and Wilmington, although there was a large factory at Springfield, Massachusetts.[60] Milwaukee was already acquiring the prominence which was later to distinguish it as a tanning center.[61]

For a time those manufacturing industries of the West which before the war had served largely the plantation market in the South, were crippled by the loss of their customers in that region. Cincinnati and St. Louis furniture factories experienced a brief depression.[62] Even meat packing was affected. But this condition speedily changed. More cattle and hogs were packed in Chicago, Cincinnati and other western centers between 1862 and 1865 than in any previous four years in the nation's history.[63]

Government war orders brought prosperity to the canners. Gail Borden, who had been experimenting for several years in condensing and canning milk opened his first permanent factory at Wassaic, New York, in 1861, two months after the outbreak of the war. "The United States Government immediately commandeered its output for the army." Hospital needs and the convenience of soldiers, who were confined at times to a makeshift diet in the field, created a market for condensed milk, and gave it a popularity that under normal conditions it might have taken many years to acquire.[64] The same demand stimulated the canning of fruits and vegetables. In 1861 improvements were made in processing canned goods at Baltimore, by which higher temperatures than previously were obtained. This extended the range of vegetables that could be packed and increased the reliability of the product.[65] During the early sixties, also, the first canneries were opened in California, and incidentally the first glass factory, which was erected to make containers for one of these enterprises.

[58] *Hunt's Merchants' Magazine*, LIII, 471, Dec. 1865; *cf. id.*, XLIV, 704, June 1861; also *Scientific American*, II, 390, June 16, 1860; VII, 102, Aug. 16, 1862; IX, 4, July 4, 1863; IX, 312, Nov. 14, 1863.

[59] *Scientific American*, XIV, 365, May 26, 1866; *Annual Statement of Trade and Commerce of Cincinnati for 1863*, p. 20; Hittell, *Commerce and Industry of the Pacific Coast*, 508–511; *cf.* also *Scientific American*, IV, 135, Mar. 2, 1861, for mention of this industry in Baltimore; Philadelphia was almost as important a boot and shoe making center as eastern Massachusetts. *Cf.* Freidley, *Philadelphia and its Manufactures*, 185–188, and Hazard, *Organization of the Boot and Show Industry in Massachusetts*, 118.

[60] *Scientific American*, V, 315, Nov. 16, 1861; VI, 67, Feb. 1, 1862; VIII, 75, Jan. 31, 1863.

[61] *Scientific American*, X, 162, Mar. 12, 1864.

[62] *Annual Statement of Trade and Commerce of Cincinnati for 1863*, 27.

[63] *Cf. De Bow's Review* (Post-Bellum Series), I, 205, Feb. 1866. Chicago took the lead as a packing center, and labor-saving devices were introduced at this time. *Scientific American*, VII, 373, Dec. 13, 1862; XI, 354–355, Dec. 3, 1864.

[64] Collins, *The Story of Canned Foods*, 95.

[65] Collins, *The Story of Canned Foods*, 16–17; cf. Depew, *One Hundred Years of American Commerce*, II, 397–398; *Scientific American*, IX, 298, Nov. 7, 1863; XI, 281, Oct. 29, 1864.

Almost at once California canned fruits became a popular luxury both in the eastern states and in Great Britain.[66]

The high tax on distilled liquors benefited the breweries by popularizing malt beverages, which were already consumed on a larger scale than in the earlier days of the Republic as a consequence of the heavy German immigration after 1848.[67] Some shifting in the geography of tobacco manufacturing followed the secession of Virginia. Richmond had been one of the most important centers of this industry, especially of the production of plug tobacco, which was at that time a relatively more important branch of the business than it is today. During hostilities new factories to take the place of those in the South were erected in New York and vicinity.[68] Detroit had become a cigar-making center of importance, from which that occupation was carried, on a factory scale, to Cincinnati.[69]

Sugar refining was stimulated by the war. Louisiana sugar, of which very little was made at best, no longer reached the northern market. Partly for this reason, and partly in response to the general effort to make the country self sustaining during the period of high taxes and inflated currency, attempts were made in 1863 and 1864 to introduce the manufacture of beet sugar in Illinois.[70] Sorghum was also cultivated to a considerable extent throughout the West. A small amount of sorghum sugar was made[71] but the principal product was sorghum syrup. In 1862 about 3,000,000 gallons of the latter were reported to have been manufactured in Ohio.[72] That year a sorghum mill at Galesburg, Illinois, manufactured 32,000 gallons, and that state's total product was estimated at well over 2,000,000 gallons.[73] Conventions of sorghum growers and manufacturers were held at Rockford, Illinois; Adrian, Michigan, and Columbus, Ohio, at which syrup, sugar and evaporating machinery were exhibited.[74] The following year sorghum mills had become common throughout the prairie states; and the production in the upper Mississippi valley reached a maximum of over 10,000,000 gallons.[75] This was the most prosperous year of the industry and was followed by a decline, due to unfavorable seasons in 1864 and 1865, and later to a return to more normal conditions of cane sugar production.[76]

[66] Collins, *The Story of Canned Foods*, 103–104. *Cf. ibid.*, 140–141.

[67] Fite, *Social and Industrial Conditions during the Civil War*, 82.

[68] *Commercial and Financial Chronicle*, v, 199, Aug. 17, 1867.

[69] *Scientific American*, x, 162, Mar. 12, 1864; Maxwell, *Manufactures of Cincinnati*, 25; Catlin, *The Story of Detroit*, 471.

[70] Vogt, *The Sugar Refining Industry in the United States*, 24–28; *Scientific American*, xi, 115, Aug. 20, 1864.

[71] *Scientific American*, vi, 75, Feb. 1, 1862.

[72] *Scientific American*, vi, 102, Feb. 15, 1862.

[73] *Scientific American*, vi, 243, Apr. 19, 1862; *Hunt's Merchants' Magazine*, xlviii, 21, Jan. 1863.

[74] *Scientific American*, vi, 329, May 24, 1862.

[75] *Scientific American*, viii, 245, Apr. 18, 1863; x, 42, Jan. 16, 1864.

[76] For the decline of cane sugar production in Louisiana during the war see *De Bow's Review* (Post-Bellum Series), i, 201, Feb. 1866.

MISCELLANEOUS MANUFACTURES

Hitherto the commercial manufacture of soap, illuminants and lubricants had been associated with the packing industry, and Cincinnati was an important center for the production of candles and of the lard oil that served simultaneously to supply the headlights and to lubricate the bearings of locomotives. About 1850 it was discovered that a valuable oil could be procured from certain grades of coal, and that by fractional distillation this product could be separated into paraffin suitable for making candles, and into an illuminating and lubricating oil.[77] A new industry, founded upon this discovery, sprang up in Scotland and in the United States. The American works were mostly in New York and New England, the principal establishment being on Long Island, and some of them used coal imported from Scotland.[78] These kerosene refineries were the precursors of the petroleum refineries erected after the first successful oil wells were bored in western Pennsylvania in 1859 and 1860. With the discovery of new and abundant sources of supply for the oil which previously had been distilled from coal, the older establishments became unprofitable except as far as they were converted to handle petroleum.[79] Most new refineries, of which several came into existence during the war, were located in the vicinity of the wells or at the principal consuming centers. It was at this time that the Rockefellers began their business in Cleveland, Ohio.[80] The adoption of heavy mineral oils for lubricating purposes came but slowly and at first they were mixed in small proportions with the lard oil which continued to be the staple machine oil of the country.[81] The rise of the petroleum industry was accompanied by that of a long line of associated manufactures—the production of well-drilling machinery, tanks and pipes, tank cars, tank vessels and lamps and burners.

Salt was discovered in the Saginaw Valley, Michigan, about the same time that oil was discovered in Pennsylvania and, like the latter, this new resource was speedily exploited. The output of this district rose from practically nothing in 1859 to more than half a million barrels in 1864.[82] The Civil War made no exceptional draft upon our chemical industries, comparable with that of later conflicts. Indeed, the demand for powder actually declined, because military requirements did not compensate for the falling off in the use of explosives in railway construction and other development work.[83] In 1861 a large powder mill, still in existence, was erected in California.[84]

[77] United States International Exhibition, 1876, *General Report of Judges, Group III*, 145–146.

[78] For a list of these, with their capacity, see *Scientific American*, II, 3, Jan. 2, 1860; II, 306, May 12, 1860; II, 363, June 2, 1860.

[79] *Cf. Scientific American*, II, 363, June 2, 1860; III, 58, July 21, 1860; VII, 68, Aug. 2, 1862.

[80] *Hunt's Merchants' Magazine*, LIII, 63, July 1865; *Scientific American*, IX, 242, Oct. 17, 1863; IX, 259, Oct. 24, 1863.

[81] *Scientific American*, II, 390, June 16, 1860.

[82] Fite, *Social and Industrial Conditions during the Civil War*, 25–26.

[83] *Scientific American*, XI, 371, Dec. 10, 1864; for an account of this industry at the outbreak of the war. *Cf. ibid.*, V, 139, Aug. 31, 1861; cf. IX, 8, July 4, 1863.

[84] *Hunt's Merchants' Magazine*, XLIX, 164, Aug. 1863; Hittell, *Commerce and Industry of the Pacific Coast*, 709–710.

For several years before the Civil War enterprising inventors and experimenters had been searching for cheaper and more abundant materials than linen rags for making paper;[85] and the manufacture of straw board and straw paper began long before the outbreak of hostilities.[86] The manufacture of mechanical wood pulp was successfully started in Pennsylvania in 1863[87] and some newspapers were printed on paper made from that material the same year. About this time American chemists were experimenting with the production of chemical wood pulp, a process that had been patented in Great Britain as early as 1852.[88] Before the end of the war, though the fact was not related with that event, this new industry had created an active demand in some localities for poplar wood.[89] The paper business was one of the first to organize for the purpose of regulating prices with the result that the conflicting interests of the publishers and paper makers were fully aired in the press.[90] At a convention of western paper makers, representing some 33 mills in the five northwestern states, held at Chicago in 1863, samples of pulp made from straw, cornhusks, sorghum and basswood were exhibited.[91] The search for new papermaking materials was encouraged by the high price of rags and other paper stock caused by speculation in these materials.[92] According to a directory of paper mills in the United States, published in 1864, there were 835 establishments in the country, of which 25 were in the seceding states.[93]

WAR PROSPERITY

Upon the whole, the war years were a period of expansion and profitable activity for the manufacturing industries of the North.[94] Earnings were high, partly on account of the steady rise of prices that accompanied currency inflation. The mill owners who lost money were those who gambled on an early peace. Even industries purveying to luxury such as the manufacture of cut glass, decorated porcelain, silks and fine dress goods throve beyond example. Nor was this prosperity supported entirely by shoddy contractors and more legitimate profiteers. The ordinary returns of our growing grain and provision exports, the enormous winnings of our petroleum pioneers, the general stimulus of active demand in a country with more natural resources than it could utilize, combined to make this an era of profitable trade, high wages and remunerative investments. Even the

[85] Weeks, *A History of Paper Manufacturing in the United States*, 213–228.
[86] *Scientific American*, II, 153, Mar. 3, 1860; V, 283, Nov. 2, 1861; Weeks, *A History of Paper Manufacturing in the United States*, 203.
[87] *Scientific American*, VIII, 291, May 9, 1863.
[88] *Hunt's Merchants' Magazine*, XLVIII, 189, Feb. 1863; *Scientific American*, XIV, 277, Apr. 28, 1866; cf. Weeks, *A History of Paper Manufacturing in the United States*, 226–227.
[89] *Scientific American*, X, 243, Apr. 16, 1864.
[90] *Scientific American*, VIII, 122, Feb. 21, 1863.
[91] *Scientific American*, VIII, 35, Jan. 17, 1863.
[92] *Cf. Scientific American*, VIII, 3, Jan. 3, 1863.
[93] Weeks, *A History of Paper Manufacturing in the United States*, 272–273.
[94] *Cf.* e.g.: National Association of Woolen Manufacturers, *Bulletin* V, vol. II, 382–384, Apr. 1871; *Scientific American*, XI, 373, Dec. 10, 1864.

fictitious gains of inflation must have impressed the popular imagination. According to the state census, between 1860 and 1865 Rhode Island increased the value of its cotton goods from $15,000,000 to $55,000,000 in spite of lessened output; the value of woolen goods rose from less than $7,000,000 to over $21,000,000; and the value of iron manufactures rose from $1,750,000 to nearly $4,500,000.[95] Between 1862 and 1864 inclusive, three score factories were built annually at Philadelphia.[96] While the manufactures of the West were still confined in the main to heavier articles like iron, furniture, agricultural implements and steam engines, which were protected from eastern competition by the cost of transportation, the increase in these branches was even more rapid than in the East.[97] Much of the usual trade of the West was cut off by the secession of the South. Such western capital and enterprise as was released by this for the time being, turned largely to manufacturing. For instance, the total value of the manufactured products covered in the Internal Revenue Report, made in the state of Missouri, increased from $13,000,000 to more than $28,000,000 between 1860 and 1866. The value of the state's iron manufactures rose from less than $3,000,000 to more than $5,000,000; the product of its breweries increased from $1,400,000, to $3,400,000; it made furniture to the value of $360,000 in 1860 and to the value of $2,200,000 six years later.[98]

To be sure statistics such as these give an exaggerated idea of progress because they use the variable yardstick of an inflated and fluctuating currency. Reduced to a gold basis, the Missouri figures show an increase of manufactured product during these six years of only 10 or 15 per cent, which suggests a rate of expansion retarded rather than stimulated by the war.[99] Yet rising prices and high profits probably did give such a stimulus.[100] During 1861 the average dividends of 24 large New England manufacturing corporations, mostly textile companies, were about 8 per cent.[101] They rose the following year to 10, 25 and in one case to 66 per cent;[102] and 1865, when dividends ranging from 25 per cent to 50 per cent were common, was stated to be "the most profitable year known in the history of the New England States."[103] In 1864 the Middlesex Mills paid a stock dividend of 50 per cent in addition to a cash dividend of 30 per cent,[104] and the James Steam Cotton Mill at Newburyport paid in a period

[95] In at least two of these industries, cotton and woolen manufacturing, there had been a loss in quantitative output. *Hunt's Merchants' Magazine*, LVII, 295, Oct. 1867.

[96] Fite, *Scial and Industrial Conditions during the Civil War*, 94–95.

[97] *Hunt's Merchants' Magazine*, XLVIII, 280, Apr. 1863.

[98] Cobb, *Preliminary Report on the Annual Value of Manufactures for the St. Louis Board of Trade*, 13.

[99] *Cf.* Mitchell, *A History of the Greenbacks*, 397–398.

[100] Mitchell, *A History of the Greenbacks*, 389–390.

[101] *Scientific American*, VI, 86, Feb. 8, 1862.

[102] *United States Economist*, quoted in *Scientific American*, VIII, 67, Jan. 31, 1863; *cf. id.*, X, 120, Feb. 20, 1864.

[103] *De Bow's Review*, Post Bellum Series, I, 430, Apr. 1866; *cf.* Fite, *Social and Industrial Conditions during the Civil War*, 84.

[104] *Bagnall Papers*, IV, 2536.

of four and a half years an aggregate of $377,500 in dividends upon a capital of $250,000, besides accumulating heavy reserves.[105] Of course wages and prices were also rising. Indeed the abnormally high dividends of some manufacturing companies often represented mercantile profits upon raw materials, whose market value had risen rapidly between their purchase and their sale as finished goods, rather than strictly industrial earnings. For instance, cotton which was worth 12¾ cents a pound delivered at New England mills in January 1861 commanded 79 cents a pound two years later.[106] Probably the factory owner profited more from this conjuncture than the primary producer, especially the farmer, whose crops were sold in an international market where the price level was not equally affected by the war.[107] A barrel of pork which in 1861 would buy 154 yards of shirting at Cincinnati, would buy but 33 yards two years later.[108] When the premium on gold began to decline, however, agricultural produce and raw materials responded to the accompanying sag in prices more promptly and decidedly than many manufactured goods.[109]

In some instances, especially in the case of cotton fabrics, ascending prices went hand in hand with a deterioration in quality.[110] Of course articles upon which new taxes were levied rose faster than other manufactures. Between 1860 and 1864 the average price of whisky, for example, increased from 22 cents to $1.45 a gallon.[111] In general "wholesale prices lagged behind gold; . . . retail prices lagged behind wholesale prices, cost of living behind retail prices, and wages behind cost of living."[112] Wages rose very slowly if at all in some sweated industries where the war had made no draft on the labor supply and where machinery was supplanting hand work,[113] while they more nearly kept pace with the ascending cost of living in organized urban trades where military exigencies increased the demand for mechanics just when volunteering and conscription were depleting their ranks. John Ericsson wrote in the spring of 1864 that in New York "the cost of forge work of every kind is three times higher than before the war; the cost of all machinery executed during the daytime is quite double and for night work the cost has quadrupled."[114] This could not have been due entirely to higher wages, however, for in 1864 the average

[105] *Scientific American*, x, 378, June 11, 1864.

[106] *Hunt's Merchants' Magazine*, XLVIII, 468, June 1863; *cf. id.*, LI, 290–291, Oct. 1864; Special Commissioner of the Revenue, *Report for 1869*, xciii, note; *Atlantic Monthly*, x, 504, Oct. 1862.

[107] World prices were also experiencing an upward cycle, however, partly in sympathy with the war. Dana, *Cotton from Seed to Loom*, 242–244.

[108] Batchelder, *The Cotton Manufacture*, 97.

[109] E.g., *Scientific American*, XI, 231, Oct. 8, 1864.

[110] *Scientific American*, VIII, 35, Jan. 17, 1863.

[111] *Commercial and Financial Chronicle*, II, 290, Mar. 10, 1866.

[112] Mitchell, *Gold Prices and Wages under the Greenback Standard*, 282; *cf. De Bow's Review* Post Bellum Series, III, 577, June 1867.

[113] Fite, *Social and Industrial Conditions during the Civil War*, 186–187.

[114] *Ericsson Papers*: Letter of John Ericsson to Chief Engineer Sturmer of the Navy Department, Apr. 13, 1864.

pay of machinists and other shipyard and engine-works mechanics was still less than $3 a day, or hardly double pre-war wages.[115]

While no such labor scarcity manifested itself in the North as occurred in the South, especially during the closing years of the war, there was a notable increase in the number of unskilled workers engaged in skilled occupations.[116] Many mechanics enrolled when the first call for troops was issued and the draft took many more.[117] Iron workers were brought from Great Britain to relieve a labor scarcity at Pittsburgh,[118] and the Federal Government instructed its diplomatic and consular representatives abroad to make known in Europe the inducements that existed for industrious workingmen to migrate to the United States.[119]

Manufacturing corporations were growing larger, groups of corporations were coming under unified control, and the general field of industrial combination was being tentatively explored before the war broke out.[120] But these early essays into larger forms of industrial organization proved for the most part premature. In the late forties an attempt was made to concentrate all the machine building of the country under one company at Lowell, Lawrence, and a few other New England towns, but standardization and quantity production in this field of manufacturing had not yet advanced to a point where such centralization was practicable.[121] But during the war Government action, in the form of tax and currency laws and public contracts, became such important factors in industrial prosperity that manufacturers were encouraged to unite in voluntary associations, and to enter into trade agreements, in order to reap the maximum benefit from the speculative conditions thus produced and to defend their interests against adverse legislation. Price-fixing agreements, which date back to the colonial period, were common. In 1862, for instance, the makers of metallic springs met at the Astor House, New York, and resolved to increase the price of their products one cent a pound.[122] Congress reduced the duty on imported print paper to check what were popularly termed the extortions of the National Paper Manufacturers' Association.[123] The sales tax which encouraged the concentration of all processes of manufacture at one establishment in order to escape paying a new impost on the same article at each successive step in its progress from a raw material to a finished product, fostered industrial consolidation in the larger sense.[124] The National Association of Wool Manufacturers, the New England Cotton Manufacturers' Association, the American Iron and Steel Association, which

[115] *Cf. Scientific American*, VIII, 74, Jan. 31, 1863; IX, 377, Dec. 12, 1863; IX, 403, Dec. 26, 1863; United States Revenue Commission, *Report, 1865–1866*, 333–334.

[116] *Ex. Doc.* No. 2, 39th Cong., 2d sess., 21.

[117] *Scientific American*, V, 211, Oct. 5, 1861; IX, 99, Aug. 15, 1863.

[118] *Scientific American*, VIII, 163, Mar. 14, 1863.

[119] *Scientific American*, VII, 267, Oct. 25, 1862; *Rebellion Records*, Series III, vol. II, 358–359.

[120] Ayer, *Some Uses and Abuses in the Management of Our Manufacturing Corporations*, 1–17.

[121] *Scientific American*, III, 368, Oct. 1, 1860.

[122] *Scientific American*, VII, 312, Nov. 15, 1862.

[123] Fite, *Social and Industrial Conditions during the Civil War*, 164; *cf. id.*, 167.

[124] See ante pp. 12–13; *cf.* Fite, *Social and Industrial Conditions during the Civil War*, 165–166.

owe their origin partly, if not chiefly, to a desire to influence tariff legislation, were established at this time, and became the lineal ancestors of the powerful societies that, with constantly expanding functions, figure so largely in the nation's industrial life today.

At the close of the war one of the most competent observers in the South wrote, after a trip through the North:

> "Concurrently with the enormous and unexampled expenditure of men, money and material which the Federal states were subjected to for five years, every one of these increased its production and added to its wealth. And this increase of wealth was permanent and visible. It is to be seen in new furnaces, mills, factories, tanneries; in the increase of iron, coal, copper, lead and zinc; in new railroads and countless oil wells; in the multiplication of machinery and the establishment of new industries; in the vast number of new vessels on lakes, rivers and canals; in the extraordinary increase of elegant and costly buildings in country and town."[125]

Allowing for the fact that the contrasts between the wasted South and the intact and growing resources of the North must have struck with peculiar vividness the vision and imagination of the war-worn visitor from the former section, nevertheless the facts themselves were indubitable. Yet this progress and prosperity were hardly the creation or even indirectly the outcome of this carnival of economic waste. They represented rather the victory of economic forces rallying from the depression of 1857, which carried us happily through the stress of the war on a tide of trade prosperity—a tide that continued to rise through all the unsettling circumstances of hostilities, peace and reconstruction, until it ebbed in the breakers of another crisis in 1873.

[125] *De Bow's Review*, Post Bellum Series, III, 174–175, Feb. 1867.

CHAPTER V

MANUFACTURING IN THE CONFEDERACY

SOUTHERN INDUSTRY IN 1861

The story of manufactures in the South from 1860 to 1865 is a record of the efforts of a people having all the needs of modern civilization, but deprived in large part of the materials that satisfy those needs—to supply themselves without previous preparation with the equipment of war and the resources of peace. The blockade of the Southern coast was effective enough to prevent ordinary commerce before supplies for the army were accumulated. Consequently traffic with the outside world did little more than serve immediate military necessities. To meet an emergency of this kind the South was in a measure prepared by the habits and condition of the people, who preserved their homespun industries and primitive self-dependence; but this section lacked, more than any other part of the country, mechanical equipment, skilled labor and the other means of developing integrated and large-scale manufacturing.

Although the factory industries of the South were thus limited in extent and primitive in technique, the seceding states were not entirely destitute of the materials, machinery, and skill necessary to insure reasonable comfort for the civilian population and to provide the means of warfare. Richmond was an industrial center of some importance, containing what were for the day extensive iron works, as well as cotton mills, flour mills and small manufacturing establishments. The only sewing machine factory south of the Potomac was in that city.[1] Georgia possessed several industrial centers of at least local importance. Augusta was a cotton manufacturing city of some ambitions; and not far distant, at Graniteville, South Carolina, was the finest cotton factory in the South. Wherever convenient water power was available, little mills had been erected to card wool, spin cotton, grind grain, or saw lumber. In a communication to the Confederate Secretary of War, in July 1861, the Governor of Alabama wrote:

> "There are three factories within 25 miles of this place (Montgomery) which can turn out 5,000 yards a day of tent cloth."[2]

Numerous forges or bloomeries supplied iron for the simple implements and vehicles used on the mountain farms. In many sections the spinning

[1] Advertisement in *De Bow's Review*, XXXI, July 1861.
[2] *I.e.* At Tallassee, Autaugaville, and Prattville. *Rebellion Records*, Ser. IV, vol. I, 493.

wheel and the loom were still familiar articles of household furniture.[3] Although there can hardly be said to have been an operative class, and skilled mechanics were few and far between, a certain handiness in the simpler manufacturing arts was very common.

When the Confederacy was organized, the South anticipated neither a long war nor a blockade. For many years previously the encouragement of local manufactures had been discussed, partly with the object of freeing that section from its commercial dependence on the North, and partly with the design of making the southern states self-sustaining from a military point of view in case secession occurred and hostilities resulted from that event. But the practical result of this agitation—if agitation it may be called—was negligible. Not a single national armory equipped to manufacture small arms and artillery was situated in the territories controlled by the Confederacy, and ammunition had not been made there since the Mexican War.[4] The equipment, modest as it was, for the Augusta Powder Works, was gathered from all parts of the South—machinery from Richmond and other points, copper from turpentine stills, and even zinc for tanks from old roofs.[5] The Tredegar Works at Richmond had made heavy ordnance for the Federal Government, and indeed these works were engaged upon a contract of this kind when secession came.[6] Machine shops and foundries were also in existence at the larger southern river ports, where steamboat machinery was manufactured and repaired. A few car shops and rolling mills had recently been established at railway towns, like Atlanta, Georgia.

CONFEDERATE MILITARY MANUFACTURES

The first task of the Confederate Government was naturally to provide itself with armories, powder mills and other factories for equipping its armies. Machinery taken from the Federal arsenal at Harper's Ferry was installed at Fayetteville.[7] The Tredegar Works, the Virginia State Arsenal, and other iron-working establishments were drafted into the service of the new government. Foundries and machine shops at places like Memphis, Holly Springs, Chattanooga, Atlanta and Augusta were put to work manufacturing artillery and muskets.[8] A large Confederate arsenal and a navy yard were improvised and rapidly extended at Selma.[9] Private promoters and furnace owners were subsidized by State and Confederate authorities

[3] New England Cotton Manufacturers' Association, *Proceedings, Boston, October 30, 1889*, 20–22.

[4] Armes, *The Story of Coal and Iron in Alabama*, 127–128.

[5] Rains, *History of the Confederate Powder Works*, 9–10.

[6] De Leon, *Four Years in Rebel Capitals*, 91–92; *Rebellion Records*, Ser. III, vol. I, 7–10.

[7] Part was retained at the Virginia State Arsenal. *Rebellion Records*, Ser. IV, vol. I, 358, 379, 469–470, 472–473, 476, 492, 504, 509. *Cf.* also *id.*, 622.

[8] Toof, *First Annual Statement of the Trade and Commerce of Memphis;* Armes, *Story of Coal and Iron in Alabama*, 165–167; Ross, *A Visit to the Cities and Camps of the Confederate States*, 171–172; *Rebellion Records*, Ser. IV, vol. I, 425, 467; *Cf.* however, *id.*, 556–557.

[9] Armes, *Story of Coal and Iron in Alabama*, 135, 140–146; Reid, *After the War*, 385; *Rebellion Records*, Ser. IV, vol. I, 108.

for the purpose of enabling them to erect new works or enlarge old ones.[10] The result was to increase considerably the production of iron, copper, lead and saltpeter.

Eventually the duty of providing these and other raw materials required for the prosecution of the war was entrusted to a Niter and Mining Bureau, consisting of a corps of officers under the War Department, originally established by an act of the Confederate Congress in April 1862, to insure adequate supplies of saltpeter for making gunpowder. This bureau's powers and functions were extended a year later to cover iron, coal, lead, copper, zinc—indeed all the raw materials that half a century afterward were placed under the control of our War Industries Board, so far as they were then procurable and employed in warfare.[11] This bureau either bought properties outright or granted funds from the Confederate treasury to develop and prosecute undertakings under contracts by which these sums were repaid by the owners in products. For instance half the cost of opening and equipping new coal mines was thus advanced to their proprietors.

IRON MAKING

Virginia and Alabama were the chief iron-making states of the Confederacy. At the peak of production some 31 furnaces were operating—though perhaps not simultaneously—in Virginia, and 16 in Alabama. Between 1861 and 1865 the South mined more than 150,000 tons of iron ore of which there is definite record, and probably the total amount was appreciably larger. Alabama's furnaces at one period had an output of 200 tons a day, and her annual production was said to be 30,000 tons of pigs and 10,000 tons of bars. The Southern furnaces were small indeed according to modern standards or even the contemporary standards of the North. In 1864 the Niter and Mining Bureau reported:

> "In one case, the Government furnace in Bibb County, Alabama, averaged through the month 13 tons of iron per day, and at another furnace I think an output of 10 tons per day was attained for one month, . . . yet the average would scarcely exceed, if equal, 4 tons per day."[12]

As a measure of the modest basis upon which the war industries of the Confederacy rested, we may mention that the aggregate iron receipts of the Niter and Mining Bureau during the two years ending January 1, 1865, were 19,539 tons of pigs and less than 7,000 tons of blooms, bars and hammered iron. A few hundred tons of copper from Tennessee and of lead from Virginia and North Carolina, less than 900 tons of niter of home production and an equal quantity imported, 2 tons of sulphur a month from domestic

[10] *Rebellion Records*, Ser. IV, vol. I, 170, 1070–1071, 1074.
[11] *Rebellion Records*, Ser. IV, vol. I, 1054; vol. II, 594; Armes, *The Story of Coal and Iron in Alabama*, 129–130.
[12] Armes, *Story of Coal and Iron in Alabama*, 185–187; *Rebellion Records*, Ser. IV, vol. III, 832–833.

furnaces and 4,000 or 5,000 pounds of sulphuric acid made at Charlotte, North Carolina, completed the receipts of metals and chemicals reported by the Bureau. A zinc furnace was operated at Petersburg for a time, but apparently only for melting scrap.[13] "Ten large furnaces in Virginia, all but three in Tennessee, all in Georgia, all but four in Alabama" had been burned or lost at the latter date, "together with many forges, foundries, and rolling mills."[14] Long before this the scarcity of metal pressed heavily upon the Confederacy. Railway iron was taken up to relay more important lines, to armor ironclads, and to supply the arsenals, and planters could not get iron to repair their implements.[15]

The manufacture of coke, which had been attempted experimentally in Alabama some years before, was renewed on a larger scale, but this fuel seems to have been used only in remelting furnaces and not for smelting ore.[16] There were six rolling mills in Alabama, besides the numerous forges, bloomeries and blacksmith shops occasionally reducing ore so frequently termed ironworks in our earlier manufacturing annals.[17] But they were small affairs, only two of which apparently were important enough to interest the Confederate authorities as producers of wagon tires and horseshoe iron.[18] Indeed after the Union forces occupied Tennessee only two mills remained in the South—the Tredegar Works at Richmond and a plant at Atlanta—that were capable of rolling rails. Neither of these could turn out more than 10,000 or 12,000 tons per annum.[19]

While there were more foundries than rolling mills in the seceding states, only two establishments outside of Richmond, one at Chattanooga and the other at Atlanta, had "the necessary tools to do large work"—that is, to cast rollers for powder mills.[20] In 1864 there was but one steam hammer in the Confederacy, and that was idle for lack of competent operators.[21] Apparently no steel of any kind was produced in the South, although in 1864, when the resources of the seceding states were already waning, experiments were made with the Bessemer process. It is doubtful if deposits of Bessemer ore had been discovered, unless the specular ores worked on a modest scale upon the Cape Fear River were of that class. The very report, of October 1, 1864, that mentions these experiments records the serious losses just mentioned, which the southern iron industry had recently suffered from the invading forces of the North.[22]

[13] *Rebellion Records*, Ser. IV, vol. III, 990–991.

[14] *Rebellion Records*, Ser. IV, vol. III, 695, Oct. 1, 1864.

[15] *Rebellion Records*, Ser. IV, vol. II, 291, 366; vol. III, 3–4, 34; *Atlantic Monthly*, LVIII, 233, Aug. 1886.

[16] Armes, *The Story of Coal and Iron in Alabama*, 144; Alabama Geological Survey, *Report of Progress for 1875*, 32; *Rebellion Records*, Ser. IV, vol. II, 779.

[17] Armes, *The Story of Coal and Iron in Alabama*, 185–187.

[18] *Rebellion Records*, Ser. IV, vol. III, 34.

[19] *Rebellion Records*, Ser. IV, vol. II, 512.

[20] *Rebellion Records*, Ser. IV, vol. I, 557.

[21] *Rebellion Records*, Ser. IV, vol. III, 695–697; *Scientific American*, XV, 283, Oct. 27, 1866.

[22] *Rebellion Records*, Ser. IV, vol. III, 695–697; *Scientific American*, XV, 283, Oct. 27, 1866.

SMALL ARMS AND ORDNANCE

When the war began there were eight "national armories" in the seceding states. These were munition depots and repair shops rather than manufacturing plants. Virginia also had an old arsenal, set up in 1800, at Richmond.[23] None of these establishments contained machinery for making arms, much less for casting and finishing cannon.[24] Nor were the energetic measures taken to remedy this deficiency at once effective. More than five months elapsed after the first hostile gun was fired before any Confederate armory began to deliver small arms, and then at the modest rate of 1,000 stand a month.[25] These were made with the machinery captured from the Federal arsenal at Harpers Ferry. When the authorities acquired the site for the arsenal at Selma they found upon it a plant estimated to be worth $40,000, which was probably as well equipped as any foundry and machine shop south of Richmond. It contained, "a pit and cupola ready to cast cannon, shot, or shell at once; four large lathes, two planers, two bolt cutters, and two forges, all in perfect order, run by an engine of about 80 horsepower."[26]

In January 1863, the Confederate Chief of Ordnance reported that more than 14,000 small arms, including pistols, had been manufactured, and that public armories could turn out 2,000 a month and private makers 1,500.[27] We have no evidence, however, that arms were ever actually produced at that rate. The following autumn the same officer reported:

> "The armories at Richmond, Fayetteville and Asheville have produced an aggregate of about 28,000 small arms within the year. Those produced at private establishments will swell this number to full 35,000 . . . . Of these about 30,000 are infantry and 5,000 cavalry arms, including among the latter 3,000 Sharps carbines; the remainder are muzzle-loading."[28]

One year later, on December 31, 1864, the Chief of Ordnance gave the capacity of the five armories then under his control, that were equipped to manufacture small arms, as 55,000 rifles and carbines a year; but lack of skilled workmen—he had only 1,225 employes in the five establishments—and other obstacles reduced the actual output to 20,000 stand, including those assembled from parts derived from capture and other sources. He estimated the daily output of northern arsenals as 5,000 stand of arms, while the South was not "making an average of 100 arms per day."[29]

During their maximum activity the Selma arsenal and the Navy Yard at that point employed 10,000 men. In addition there were 14 or 15

[23] *Rebellion Records*, Ser. III, vol. I, 48; Ser. IV, vol. I, 469.
[24] Armes, *Story of Coal and Iron in Alabama*, 127–128.
[25] *Rebellion Records*, Ser. IV, vol. I, 622.
[26] *Rebellion Records*, Ser. IV, vol. I, 108.
[27] *Rebellion Records*, Ser. IV, vol. II, 299.
[28] *Rebellion Records*, Ser. IV, vol. II, 957.
[29] *Rebellion Records*, Ser. IV, vol. III, 677, 987; *cf.* Channing, *History of the United States*, VI 616–618.

private shops and foundries in the same city. Here were cast cannon 10 to 18 feet long and 2 to 3 feet in diameter, banded with wrought iron at the breach. At the Navy Yard in Selma the ironclads were built that met Farragut at Mobile Bay. These boats were thickly plated with three layers of 2-inch wrought iron slabs.[30] In the same city were shops for manufacturing saddlery, harness, knapsacks and wagons.[31]

But the Tredegar Works at Richmond, which continued to run as a private institution throughout the war, were larger than the Confederate Arsenal and the Confederate Navy Yard at Selma combined. This establishment covered 32 acres. An Englishman who visited it soon after hostilities began reported that he was "perfectly astonished at its extent." He observed rolling mills, cannon and other foundries, machine shops and locomotive works. Adjoining this establishment was the state armory, which according to this visitor was apparently getting "into a condition of desuetude."[32] Another British visitor to the South about this time mentions the "slate-roofed Tredegar Works; their tall chimneys puffing endless black smoke against the sunshine . . ." and adds, "So potent a factor in the aggressive power of the Confederacy was this foundry that it overtopped the regular government." He comments further—

"During the war it greatly increased in size; added to its utility by importation of costly machinery through the blockade; stood the loss of one-third its buildings by fire; used a ship of its own for imports; and at the close of the struggle was in better condition than at the commencement . . . . It was at the Tredegar Works that the famous Brook gun—a rifled 7-inch cannon—was cast, tested and perfected. Here the plates for the ironclads in almost all southern waters were rolled or made ready for use. Here heavy ordnance for the forts was cast, together with shells and shot; and here the torpedoes—sometimes so effective, and usually so useless—were contrived and made . . . The works had mines, mills, and pork packeries in various sections of the South, thus obtaining coal and metals as well as food, at reduced rates within reach of their wages for an army of employes."[33]

POWDER MILLS

At the outbreak of the war there were five small powder mills within the territories of the Confederacy, none of which seems to have been in operation.[34] Charcoal was easily obtainable, but sulphur and saltpeter were lacking. A domestic supply of the former was eventually procured from the pyrites of the copper mines and of the latter from caves and artificial niter beds.[35] At times the shortage of these materials, though supplemented by

[30] American Iron and Steel Association, *Bulletin*, XXIII, 156, June 12, 1889.
[31] Armes, *The Story of Coal and Iron in Alabama*, 135, 144–146.
[32] Day, *Down South, or an Englishman's Experience at the Seat of the American War*, I, 78–79.
[33] De Leon, *Four Years in Rebel Capitals*, 91–92.
[34] *Rebellion Records*, Ser. IV, vol. I, 293, 555; Rains, *History of the Confederate Powder Works*, 5.
[35] *Rebellion Records*, Ser. IV, vol. I, 556; vol. II, 957; vol. III, 990.

importations through the blockade, seriously limited output. In January 1862, President Davis informed Congress that

"The mills now in existence and which could be readily put to work far exceed in their ability to manufacture our ability to supply the requisite material."[36]

Under the best conditions the yield of saltpeter reached 2,000 pounds a day and "very nearly met the demand of this service," but 40 per cent of this was obtained from sources liable to interruption by military operations.[37] Through the quality of southern powder was inferior to that imported, and doubtless to that which the DuPonts and other veteran makers in the North were supplying to the Union Armies, sufficient ammunition seems always to have been provided for the exigencies of the campaigns.

The largest powder mills were those erected by the Confederacy at Augusta. Their output at an emergency was 10,000 pounds a day; and between April 10, 1862, and April 18, 1865, they made 2,750,000 pounds of powder for the Richmond Government. Yet one steam engine of 130 horse power, originally designed for a flour mill, was sufficient to run them.[38] Another Government mill was put in operation at Columbia, South Carolina, and a third was established at San Antonio, to use materials run through the loose blockade along the Mexican border.[39] At the end of 1864 the Niter and Mining Bureau was operating four mills—at Augusta, Selma, Raleigh and Richmond. The last of these was just on the point of beginning, and the list did not include the Navy mill at Columbia. These four establishments then had a capacity of 7,600 pounds of powder a day, or less than the Augusta mill was reported to have made at the time of its maximum activity. One private mill, at Charlotte, North Carolina, was also reported.[40] No mention is made in this account of the mill at San Antonio. Indeed the modest war industries of the South west of the Mississippi, which included two or three iron furnaces, were almost completely cut off from communication with the capital of the Confederacy during the last years of hostilities.

TEXTILE INDUSTRIES

When the southern volunteers flocked to the colors, many companies and regiments were provided with uniforms and equipment by the household looms and village workshops of the districts from which they came. Typ-

[36] *Rebellion Records*, Ser. IV, vol. I, 864.
[37] *Rebellion Records*, Ser. IV, vol. II, 222–223.
[38] Rains, *History of the Confederate Powder Works*, 9, 26; *Rebellion Records*, Ser. IV, vol. I, 557.
[39] *The Index*, II, 104, December 11, 1862; *Scientific American*, VI, 326, May 24, 1862; *id.*, VIII, 275, May 2, 1863; McClure, *The South*, 75; Ross, *A Visit to the Cities and Camps of the Confederate States*, 169–171; Freemantle, *Three Months in the Southern States*, 177–179.
[40] *Rebellion Records*, Ser. IV, vol. III, 987.

ical of this situation was the information submitted to the Secretary of War by a citizens' committee of Lincoln County, Tennessee:

"From our wool we can make blankets, clothing and socks, and clothe every man we have in the field (about 900) if necessary."[41]

All districts were not so fortunate in having wool, but homespun industries continued throughout the war, even after commutation was abolished late in 1862,[42] to supplement materially the clothing furnished the common soldiers by the Quartermaster's Department. The state governments also contributed to these supplies.[43] But the Confederate Government soon commandeered or otherwise controlled the little woolen mills and cotton factories scattered throughout the seceding states, to manufacture cloth for military uses. The South did not raise enough wool to clothe the civilian population, much less to provide uniforms and blankets for an army in the field.[44] Notwithstanding the obstacle of the blockade the Confederate authorities secured from abroad a good share of the woolen goods used by the army.[45] Cotton was substituted for wool wherever possible and one enterprising manufacturer submitted a cloth made of equal parts of wool and cow-hair.[46]

Not only the Confederate Government but the state governments took up the direct encouragement of manufacturing. During the war the North Carolina authorities expended over $20,000,000 in Confederate currency upon manufacturing enterprises. In 1861 there were 8 woolen mills and 40 cotton mills within the state, which were more or less under the jurisdiction of its Manufacturing Board. The authorities impressed the output of the cotton mills at 75 per cent advance on the cost of production, allowing the mills to keep their own accounts. This rate was, at least in some cases, less than previous profits and was not uniformly observed.[47] Georgia had 31 cotton and woolen mills in 1861, with an estimated output of 473,000 yards of coarse cotton fabrics and 46,000 yards of woolen cloth a week.[48] Yet such was the scarcity that private homes were stripped of every available woolen fabric, even to the rugs on the floors, in order to provide for the army.[49]

The industrial unpreparedness of the South for war may be measured by the extent to which manufacturing was either controlled or directly prosecuted by the public authorities. In both the North and the South the

[41] *Rebellion Records*, Ser. IV, vol. I, 507; *De Bow's Review*, XXXII, 332–333, Mar.–Apr. 1861.
[42] *Rebellion Records*, Ser. IV, vol. II, 202.
[43] *Rebellion Records*, Ser. IV, vol. III, 1040.
[44] *De Bow's Review*, XXXI, 555, Dec. 1861; Ramsdell, *Control of Manufacturing by the Confederate Government*, in *Mississippi Valley Historical Review*, VIII, 240, Dec. 1921; *Rebellion Records*, Series IV, vol. II, 654–655; cf. *Atlantic Monthly*, LIII, 248, Feb. 1884.
[45] *Rebellion Records*, Ser. III. vol. II, 771; Ser. IV, vol. I, 557; vol. II, 955; vol. III, 674.
[46] *Scientific American*, X, 243, Apr. 16, 1864.
[47] North Carolina Historical Commission, *Unlisted Papers; Rebellion Records*, Ser. IV, vol. II, 161, 183; Thompson, *From the Cotton Field to the Cotton Mill*, 55–57.
[48] *De Bow's Review*, XXXI, 556–557, Dec. 1861; *Lloyd's Southern Railway Guide, passim.*
[49] *The Index*, II, 105, Dec. 11, 1862; *Atlantic Monthly*, X, 504, Oct. 1862.

Government operated armories, clothing factories, and other establishments for supplying the army and navy; but in the North a large part of these needs was furnished by private producers bidding in the open market, while in the South the portion thus supplied was relatively small. For example, the Confederacy made all its domestic powder in public factories, but the Federal Government procured its entire stock from private makers.

Many cotton and woolen mills were destroyed in the course of hostilities by Federal raiders. General Grant describes in his *Memoirs* the burning of one such establishment at Jackson, Mississippi.[50] Furthermore, cotton machinery wore out and could not be replaced. This was particularly true of card clothing. The state governments of both Virginia and Georgia appropriated money from their public treasuries to import card clothing and carding machinery from Great Britain.[51] The Confederate Government tried to import machinery for manufacturing shoddy and blankets.[52] Georgia appropriated $1,000,000 for a card factory and such an establishment was operated under the auspices of the state at Cartersville.[53] Although spinning and weaving were common household arts, the implements employed were surprisingly primitive. In 1864 a committee of the Virginia legislature recommended an appropriation to "furnish the counties of the state with a model of the flying shuttle attachment for looms,"[54] and a British observer describing the manufactures on a southern plantation the same year reported:

> "There is neither picking stick nor any other article to throw the shuttle across, this operation being performed simply by hand."[55]

Altogether, the South is estimated to have spun 200,000 bales of cotton annually into coarse yarns, part of which was woven into sheeting, drill and osnaburgs in factories, and part of which was sold to country people to be woven on household looms.[56] The cultivation and manufacture of flax had never entirely ceased in the mountain counties, and a flax warp, cotton weft fabric which had been common throughout the British colonies before the Revolution, was still manufactured in considerable quantities in those districts.[57]

MISCELLANEOUS MANUFACTURES

Country tanneries were common enough in the South, but the supply of leather soon proved inadequate.[58] Governor Vance of North Carolina

[50] Grant, *Personal Memoirs*, I, 507; Thompson, *From the Cotton Field to the Cotton Mill*, 58.
[51] Virginia State Doc., *Journal of the State*, Sess., Dec. 7, 1863, 154; *cf. id.*, *Senate Reports* Nos. 14 and 18; *Cf.* Advt. *Lloyd's Southern Railway Guide*, June, 1864.
[52] *Rebellion Records*, Ser. IV, vol. III, 683.
[53] Georgia, *House Journal*, Sess. 1864, pp. 60, 71–72, 82; *id.*, Extra session 1865, 65.
[54] Virginia *Sen. Doc.* 14, Sess., Dec. 1864; Extra session, p. 3.
[55] *The Index*, IV, 301, May 12, 1864.
[56] *The Index*, II, 105, Dec. 11, 1862.
[57] *Cf.* New England Cotton Manufacturers' Association, *Proceedings*, *Boston*, *October 30, 1889*, pp. 20–22; Fleming, *Home Life in Alabama*, in *Publications of the Southern Historical Association*, March 1904, p. 89; Mitchell, *The Rise of Cotton Mills in the South*, 19, footnote 27.
[58] *Cf.* Ramsdell, *The Control of Manufacturing by the Confederate Government*, in *Mississippi Valley Historical Review*, VIII, 244–248, Dec. 1921; *Rebellion Records*, Ser. IV, vol. III, 683, 988.

informed the Confederate Government that two-thirds of the leather produced in the state was used for making harness, and suggested that cotton be employed in its place in order that more leather might be available for foot wear. Home-made cloth shoes were frequently worn by ladies. At the outbreak of the war a few factories using "machines of Yankee invention" had been established in southern cities to manufacture plantation brogans and other coarse foot wear for slaves and laborers.[59] The Confederate authorities exerted themselves up to the closing months of the war, to procure shoemaking machinery from abroad.[60] By 1864 southern soldiers captured by the northern army in some instances wore shoes with wood soles, to which coarse leather tops were nailed with tacks and welts.[61] An English merchant who visited the South in 1862 reported that—

> "The people had been compelled to become shoe-makers, tailors, cotton spinners, mechanics, and so on; and, whether they consider it a compliment or not, it is a fact that there is enough of the Yankee about them to invent and make machines, and look uncommonly sharp after making them pay well, too."

At Jackson, Mississippi, this visitor paid 35 cents for a square of Confederate-made soap "about the size of a small billiard ball, the color of clay, and the consistency of stiff curds." He paid 25 cents a box for Confederate matches, of which the seller candidly remarked that not one in five would light.[62]

Richmond had long been one of the largest flour mill centers in the United States, and there were also mills of considerable size at Augusta and other shipping points on the southern rivers. Plenty of coarse food was produced and preserved, although meat was imported in considerable quantities [63] and in 1864 the legislature of Georgia passed a resolution requiring planters and farmers to curtail their cotton crops and to increase the production of grain and provisions.[64] Most of the states passed laws prohibiting distilling, which were at times enforced even against the Confederate Government, and caused heated correspondence between several state governors and the military authorities.[65] Difficulty was experienced in procuring salt. The earthen floors of smoke houses were dug up and leached. The only important salt wells in the Confederacy were in southwestern Virginia and the manufacture was controlled by the state. Alabama, Georgia and North Carolina likewise put up works in that vicinity.[66] Sea salt was also manufactured at Wilmington and other places, but never in sufficient

[59] *Cf. De Bow's Review*, xxx, 371–372, Mar. 1861.
[60] *Rebellion Records*, Ser. iv, vol. iii, 683.
[61] *Scientific American*, x, 405, June 25, 1864; *Atlantic Monthly*, lviii, 232, Aug. 1886.
[62] An English Merchant, "*Two Months in the Confederate States*," quoted in *The Index*, iii, 28, May 7, 1863.
[63] *Rebellion Records*, Ser. iv, vol. iii, 955.
[64] Georgia, *Journal of the House of Representatives*, 1861, p. 387; *cf.*, *Rebellion Records*, Ser. iv, vol. ii, 476.
[65] *Cf. Rebellion Records*, Ser. iv, vol. ii, 218, 511, 513, 1072–1073; vol. iii, 23–24, 106–107, 115, 117, 118–119, 120, 481–482, 875–876, 1063–1064, 1074.
[66] Schwab, *The Confederate States of America*, 267–268.

abundance to supply the market.[67] A description of life in the Confederacy written immediately after the war, summarizes the experience of the southern people during the northern blockade in a sentence which was repeated with variations innumerable times in Germany a half century later: "It was a day of substitutes."[68]

As the war progressed and made increased drafts upon the manhood of the South, the problem of supplying labor for heavier manufacturing became increasingly difficult. Slaves were employed in the southern spinning and weaving mills to some extent,[69] and performed much of the heavy work at foundries and iron works. Northern prisoners who were discovered to be skilled mechanics were offered inducements to work in southern arsenals.[70] Artisans were also procured from Europe.[71] Skilled mechanics and operatives were exempted from military service while employed in manufacturing establishments: indeed, the exemption law was one of the chief agencies through which the authorities regulated private industry.[72] An attempt was made as early as 1861 to repeal the child labor law enacted by the State of Georgia in 1854.[73] The lack of competent metal workers and machinists was never remedied; it seems to have been the limiting factor in the production of arms and munitions up to the very close of the conflict. Among the early acts of the Confederate Congress was a law, approved in 1861, to establish a patent office, which during its first year of existence granted 304 applications for patents.

Profiteering, the inevitable accompaniment of a protracted war, was as characteristic of the South as of the North, and of the sixties of the last century as of the second decade of its successor.[74] The blockade, the rapid depreciation of the currency, the whole complex of business conditions in the Confederacy caused all commercial transactions to be attended with a high degree of risk. According to contemporary reports and such evidence as is obtainable regarding the contracts between manufacturers and the Government, Southern factory owners made large profits during the war. In 1863, 120 establishments in Virginia were taxed on a basis of more than $3,000,000 net earnings. These included 66 tanneries, 16 spinning mills, 14 flour mills, 5 iron works, 9 coal mines, 9 salt works, and 1 paper mill.

[67] Salt works near the coast were an object of attention for the Federal Navy. *Ex. Doc.* 1, 37th Cong., 3d sess., 267–269; *Report of the Secretary of the Navy*, Dec. 1863, 277–278, 294; *id.*, Dec. 1864, 154, 197–202, 318–319, 360–362, 372, 377–379, 384, 487–489; *id.*, 1865, 350–351; *Rebellion Records*, Ser. IV, vol. II, 182; *Atlantic Monthly*, LVIII, 230–231, Aug. 1886.

[68] *De Bow's Review*, Post Bellum Series, II, 570–572, Dec. 1866; *Atlantic Monthly*, LVIII, 230, Aug. 1886.

[69] *The Index*, IV, 301, May 12, 1864.

[70] *Scientific American*, X, 342, May 25, 1864; *Rebellion Records*, Ser. IV, vol. III, 863–865.

[71] Freeman, *A Calendar of Confederate Papers*, 201; *Rebellion Records*, Ser. IV, vol. I, 993; vol. III, 521–523, 734.

[72] The labor problems of the Confederacy are ably discussed in Ramsdell's, "The Control of Manufacturing by the Confederate Government," in the *Mississippi Valley Historical Review*, VIII, 231–249, Dec. 1921; *cf.* also *The Index*, II, 105, Dec. 11, 1862; *Rebellion Records*, Ser. IV, vol. I, 1081, 1110; vol. II, 143, 204.

[73] Georgia, *Journal of the House of Representatives*, 1861, 387–388.

[74] *Atlantic Monthly*, LVIII, 230, Aug. 1886.

A single Confederate factory was assessed for profits of $355,000; a woolen mill had declared dividends of $530,000 on a capital of $200,000 and a paper mill had during 1861 and 1862 paid 575 per cent dividends on its investment.[75] As previously mentioned, the State of North Carolina and the Confederate exemption law allowed mill owners a profit of 75 per cent on cloth manufactured for the Government, but the Confederate authorities later fixed this rate at $33\frac{1}{3}$ per cent, and in some cases as low as 25 per cent.[76]

In 1862 Virginia, according to a contemporary account, had factories or workshops for manufacturing cotton and woolen goods, boots and shoes, and machinery; North Carolina made cotton and woolen fabrics, hats, rifles, sewing machines (sic), boots and shoes, powder, linseed oil, cottonseed oil, and side arms; and South Carolina reported cotton and iron and steel manufactures.[77] When the war broke out there were 15 paper mills in the seceding states, producing about half the paper normally consumed in that section. They suffered the usual vicissitudes of hostilities, though some replacement supplies were brought through the blockade.[78]

At Memphis during the first year of the war—

"from 1,200 to 1,500 persons, men and women, were actively engaged in the production of clothing, camp equipment, cartridges, percussion caps, knapsacks, cavalry equipment, to say nothing of the very considerable force employed at the iron foundry and the machine shops—turning out field pieces of various descriptions, shot and shell, swords, knives, and warlike implements generally. . . . The facilities for manufacturing flour have been largely increased and during the last two months the production has averaged 4,000 barrels a week."[79]

Primitive as were such little industrial enterprises, they seem to have aroused the hostility of some planters, who distrusted even these diminutive forerunners of the industrial revolution as a dangerous innovation in the agricultural South. Especially did they dislike the introduction of a mechanic and operative population. A southern editor wrote in 1863:

"Mills and manufactories on every stream and in every valley would be a poor compensation for the introduction of such a crew of the sons and daughters of Belial; and no wonder that those who cling with love, which is often the highest form of reason, to the old framework of our society, shudder at the thought of a Lowell on the Appomattox, or a Manchester in the Piedmont region."[80]

[75] Schwab, *The Confederate States of America*, 272.
[76] North Carolina Historical Commission, *Unlisted Papers;* Ramsdell, "The Control of Manufacturing by the Confederate Government," in *Mississippi Valley Historical Review*, VIII, 235, 237, Dec. 1921; *cf.* however, Thompson, *From the Cotton Field to the Cotton Mill*, 57–58.
[77] *De Bow's Review*, XXXII, 158–160, Jan.–Feb. 1862; XXXII, 327, 332, Mar.–Apr. 1862.
[78] Weeks, *A History of Paper-Manufacturing in the United States*, 269.
[79] Toof, *Annual Statement of the Trade and Commerce of Memphis*, 1861, 9.
[80] Quoted in *Scientific American*, IX, 386, Dec. 19, 1863.

This representative of the Old South looked forward with dread to the time when

> "Yankees and Yankified southerners are to dye the rivers of Virginia with indigo and copperas, and make her skies black with the smoke of furnaces. Then the fatal process which led to the dissolution of the old Union will be repeated and another fratricidal war inaugurated."

Northern raiders destroyed every manufacturing establishment in southern territory that they were able to reach. The military need of beating down the economic resistance of the enemy was as well understood and as relentlessly applied in 1864 as it was in Europe a half century later. During Sherman's campaign in Georgia and the Carolinas, most of the little spinning mills along the fall line of the southern Appalachian rivers were burned. As already mentioned, every important iron works in Alabama was wrecked, and Wilson's raid was an episode of historic interest in the manufacturing as well as the military annals of the South. Yet the history of manufactures in the Confederacy is almost unrelated with the general manufacturing history of the nation; it constitutes a separate chapter without introduction or conclusion. To be sure, not every manufacturing establishment south of the Potomac was ruined by the war. The finest cotton mill in the South, at Graniteville, South Carolina, and the largest iron works in the South at Richmond, were left practically untouched by direct violence. But the period of reconstruction found the manufactures of the South far behind the position they had acquired in the promising earlier period of their development, during the decade which closed with the panic of 1857.

CHAPTER VI

BUSINESS CONDITIONS DURING RECONSTRUCTION

CONTRAST BETWEEN THE SOUTH AND THE NORTH

When hostilities ceased in the spring of 1865, the two sections of the country which had been parties to the conflict presented a striking contrast in respect to industrial conditions. The Confederacy had not only lost the war, but it had lost the social organization upon which its economic life had previously been based. Its meager manufacturing equipment had been mostly wrecked by invaders or at least depleted almost to the vanishing point by the waste and wear of the conflict. The railways, except so far as they had been maintained and operated by Federal forces were dilapidated or completely ruined. Confederate bonds and currency became worthless and the country was left for the time being with weakened institutions of credit and an inadequate circulating medium. Men who a few years previously had been wealthy were paupers. Both statutory law and judicial precedents were placed in question. Old debts became due and new ones were canceled. More important still, the slaves were freed.

Though the abolition of slavery, like the devaluation of Confederate currency and securities, did not lessen directly the wealth of the South as a community, except insofar as it may have reduced the productivity of labor, both events tended to cripple industry and temporarily to check the recovery of the country. Last of all was a political factor—the bitter hatred which the people of the former Confederacy and the Union felt toward each other, an alienation which was sure to express itself overtly or covertly in the policies and legislation of the Federal Government.

A very different picture was presented by the industry of the North. This section had not suffered appreciably by invasion. Its mills and factories were intact; the equipment of most branches of manufacturing had increased largely during the course of hostilities. Labor was fully employed. Commerce was active. New railways and highways had been constructed. New sources of natural wealth had been developed. Superficially the North was still sailing the crest of a wave of war prosperity.

With the restoration of the Union, northern manufacturers again had a first call upon the markets and the raw materials of the South. The mercantile stocks of the entire country were more or less depleted. The reconstruction of war-devastated regions promised to create a large demand for the products of Northern furnaces and mills.

The states of the former Confederacy drew one advantage from their defeat; the public debt which they had incurred to carry on the conflict was extinguished. But their citizens had to bear a share of the cost of the war against them. On the whole this region had fair sources of credit. It possessed a moderate stock of cotton and the prospect of a larger crop the coming year. This was an immediate cash asset. The North had faith in the economic recovery of the South—indeed, an exaggerated faith in the speed with which this recovery would occur, for there were optimistic theories abroad regarding the higher efficiency of the negro in a state of freedom. As subsequent experience proved, it was only too easy to tap the springs of public credit in the reconstructed states for capital to build new railways and public works, which were not always of the most productive character. So the southern market helped to replace the military market which ceased to exist as soon as peace was signed.

The promise of market expansion also existed in the still undeveloped West. Thousands of discharged northern soldiers, encouraged by Federal laws in their favor, hastened to the frontier to take up land. They were joined there by no inconsiderable numbers of the very men whom they had been fighting during the past four years.

Yet northern manufacturers did not face a cloudless horizon. They confronted the problem of converting factories which had been working for the Government, and mainly upon goods demanded by the army or navy, into establishments producing the wares of peace.[1] They found it impossible to predict future prices, since no one knew how rapidly greenbacks would approach par. Last of all, they were exposed to the manifold uncertainties and caprices with which emergency war legislation always surrounds and hampers the economic activities of a nation. The customs revenues represented a larger percentage of value of the total imports of the country than ever before in its history during a period of normal trade, and they were a larger percentage of the dutiable imports than ever before, except for the single year of 1830. But manufactures had been protected still further by the premium upon gold, which greatly enhanced the cost of imported merchandise to all who received their income in paper money. On the other hand, however, this premium probably encouraged the rapid flow of foreign capital to America, which contributed to the abnormal business activity that followed; and this inflow occurred largely in the form of goods. Furthermore the heavy internal revenue tax upon domestic manufactures continued for the time being to be levied. It applied not only to finished goods but also to many raw materials, and might in certain conditions add materially to production costs.

TAXATION DURING RECONSTRUCTION

This legislation did not end with the war. Indeed, in 1866 the Government, apparently under the impression that the tax would be paid largely

[1] *E.g.* Bridge, *Inside History of the Carnegie Steel Company*, 25.

by British purchasers, laid an impost of 3 cents a pound upon raw cotton against the better opinion of manufacturers in the North and the bitter protests of the planters in the defeated states. Congress granted a rebate of this tax to domestic manufacturers when the product of their mills was exported. This was a short-lived statute and during its brief period of enforcement it did little to encourage the manufacturing of cotton goods in America for foreign markets.[2]

Taxation was a heavy burden both upon the individual and upon particular industries. In 1866 the total internal revenue raised from domestic manufactures was over $178,000,000.[3] The per capita tax of the United States was estimated to be $16.04 in currency or $11.46 in gold, probably the heaviest at that time paid in the world. It was computed to amount to about 4 per cent per annum upon the entire capital of the country. More than $48,000,000 was raised by the tax of 6 per cent on the output of the woolen mills in Massachusetts alone. This was equivalent to nearly 20 per cent of the whole capital invested in these establishments. The tax on the boot and shoe industry was even higher in proportion to the capital employed, amounting according to contemporary estimates to 30 per cent upon the entire investment.[4]

These heavy fiscal burdens seem to have been borne without much protest by the people, who were eager to see the public debt reduced as rapidly as possible. It was asserted, however, that the removal of internal taxes would materially lower the cost of manufactured articles for consumers. David Wells, who was the leading economic publicist in the country at the time, predicted that this would be the outcome. Nevertheless four years after the war was ended, when most of these taxes had been removed, prices remained unchanged. Indeed, pig iron, lumber, salt and certain other articles of basic importance to the industries of the country had actually advanced. So marked was the tendency to maintain prices at or above their former level after this taxation was abolished, that the Commissioner of Internal Revenue, who in 1866 had reported that the existing system entailed and maintained an undue enhancement of prices, commented later that "the repeal of the internal tax, through the maintenance of former prices, has been only equivalent to legislating a bounty into the pockets of the producers."[5]

The total amount of protection afforded manufacturers by the customs duties was materially increased by the successive removals of the internal taxes upon both finished goods and raw materials; and as a consequence the industrial interests of the country were more securely intrenched behind

[2] *De Bow's Review*, Post Bellum Series, III, 66–67, Jan. 1867; *Hunt's Merchants' Magazine*, LV, 409–411, Dec. 1866; LVIII, 33, Jan. 1868; *cf.* Davis, *Authentic History of the Ku Klux Klan*, 51–54.

[3] Special Commissioner of the Revenue, *Report for 1868*, 84.

[4] *Scientific American*, XVI, 34, Jan. 19, 1867.

[5] Special Commissioner of the Revenue, *Report for 1868*, 23.

a barricade of Government favors five years after the war than they were at the conclusion of hostilities.

On March 17, 1866, the reciprocity treaty with Canada, which had been in force more than a decade, was terminated by act of Congress. The only manufacturers materially affected were the worsted combers and spinners of New England. The treaty, partly on account of hostile legislation north of the border, had not favored the exportation of our manufactured goods to Canada to the extent anticipated.[6] Union sentiment was hostile to our northern neighbors, because of the favor which some of them had shown the Confederacy. Indeed, an argument advanced for levying a higher duty on coal was that this would exclude the product of the Nova Scotia mines, whose customers had included blockade runners and Confederate privateers. Among the very modern grievances against our neighbors was that whisky was manufactured in Canada, "merely for the purpose of being smuggled into the United States," where our internal revenue tax added to the price of the domestic product.[7] Yet opposition to the abrogation of the treaty with Canada was very powerful, especially in New England and some border cities—notably Buffalo and Detroit.[8] A few furniture factories suffered from being cut off from supplies of Canadian timber.

One effect of the war had been to encourage the establishment of American manufacturing plants in Canada, in order to escape taxation, especially when a part of the product was shipped to foreign markets.[9] For instance, a leading firm of varnish makers transferred a portion of its factory from New York to Montreal with the object of holding its foreign customers, since it was impossible otherwise to compete with European and British manufacturers on account of the high cost of raw materials in the United States.

FLUCTUATING PROSPERITY

Attempts were made by the reconstruction governments and their successors to encourage manufacturing in the southern states. During 1866 and 1867 Georgia incorporated several manufacturing companies. In fact, as soon as settled conditions were restored an effort was made throughout the South to rebuild her ruined mills and factories, an effort possibly inspired in part by a realization, brought home by the war, of the superiority in wealth and power that an industrial nation enjoys over an exclusively agricultural country. The break-up of the old social system left the South filled with footloose men, ready to embark in new and speculative enterprises. A number of demobilized northern soldiers and officers who had become familiar with certain sections of the Confederacy during the pre-

[6] *Sen. Doc.* 80, 62d Cong., 1st sess., Part 1, 872–873.
[7] *Sen. Doc.* 80, 62d Cong., 1st sess., Part 1, 466–468, 590; American Iron and Steel Association *Bulletin*, XXII, 89, Mar. 21, 1888.
[8] *Sen. Doc.* 80, 62d Cong., 1st sess., Part 1, 495–497, 533, 621.
[9] *Sen. Doc.* 80, 62d Cong., 1st sess., Part, 1, 590–642.

vious campaigns, tried their fortunes there after peace was restored. Although this brief recovery was followed by a long period of discouragement and reaction, it left some impression upon the legislation and business psychology of that section.

The close of the war found the re-united states with a large amount of replacement and deferred development work to be performed. What a contemporary writer called "the natural exhilaration" at the close of such a conflict helped to create an atmosphere of business optimism. European capital manifested renewed confidence in a democracy that had survived such a baptism of blood.[10] Immigration soon rose to unprecedented figures, and during the following 15 or 20 years the country received the highest class of aliens that had come to its shores since colonial days, including a large inflow of skilled artisans and farmers from Great Britain and northern Europe. These conditions combined to stimulate industry and to promote public improvements. Consequently, although the business world faced serious uncertainties on account of the unstable value of the currency, the prospective revision of the war laws, and an anticipated decline of prices, there was no real set-back in most lines of manufacturing following the cessation of hostilities.

To be sure, in 1866 current production was already gaining noticeably upon consumption, and goods began to accumulate in the hands of the manufacturers. Perceiving this tendency, inland merchants became cautious buyers, anticipating that prices might speedily fall to their pre-war level. But they were equally cautious in buying imported goods; for it was felt that the existing premium on gold could not be maintained, and that the return of the dollar to par would be accompanied by an abrupt decline in the cost of foreign merchandise. The same considerations influenced importers to place smaller orders than usual in Europe, although their purchases of the previous year had found ready buyers in this country.[11] While high prices and the premium on gold checked mercantile buying, they also checked consumption among the people, and soon complaints of overproduction began to be heard. By the following autumn some manfacturers were curtailing output and merchants reported their business below the average. The failure of three important textile concerns in New England and New York added to the prevailing uneasiness in industrial and commercial circles.[12] Many woolen mills shut down entirely. Others reduced their working day to eight hours.[13] By the spring of 1867 it was estimated that average production in that branch of manufacture had diminished quite 20 per cent. New England cotton mills also curtailed operations and the leather and iron trades were depressed.[14]

[10] *Commercial and Financial Chronicle*, XXI, 218, Sept. 4, 1875.
[11] *Commercial and Financial Chronicle*, III, 196, Aug. 18, 1866: There was a sharp money panic in London this year.
[12] *Hunt's Merchants' Magazine*, LV, 396–397, Nov. 1866.
[13] *Hunt's Merchants' Magazine*, LV, 471–472, Dec. 1866.
[14] *Hunt's Merchants' Magazine*, LVI, 169, Mar. 1867.

Yet there was a considerable increase in the country's manufacturing equipment during the two years following Lee's surrender. In his report for 1867, the Commissioner of Internal Revenue estimated that from 15 to 20 per cent more cotton spindles were then in operation in the United States than at the beginning of the war.

"Notwithstanding the recent universal depression of the woolen industry, the erection of new mills has continued with a reported general improvement in the character of the product."

Our furnaces produced more iron than ever before in the history of the country. New rolling mills were erected and old ones were in constant operation. The Bessemer steel industry was beginning to achieve commercial success. During the previous ten years the annual ratio of increase in the production of pig iron had been greater in the United States than in Great Britain.[15]

Meanwhile the price of agricultural products remained high. Wheat reached its maximum quotation for the decade during 1866 and 1867. Pork still cost twice as much as it did in 1860. These conditions suggested the inference that the war had left the country with an undue proportion of its capital and labor engaged in manufacturing. Factory owners agitated for a removal of internal revenue taxes upon their products and raw materials, and for an increase or at least the maintenance of existing customs duties.[16] At the same time the common people were protesting against the continuance of high prices. In 1866, David Wells estimated that the advance in the cost of living amounted to 90 per cent as compared with the average for the four years ending with 1862. Breadstuffs had risen 70 per cent, provisions more than 100 per cent, coal 60 to 70 per cent, domestic cottons 172 per cent. Woolens had not risen with equal rapidity, the advance being estimated at only 53 per cent. Ready-made clothing, perhaps on account of the use of sewing machines, was only 50 per cent higher than at the outbreak of the war.[17]

The Secretary of the Treasury imputed to a redundancy of currency and a "fallacious inflation of values" a decline in American enterprises on sea and land, exhibited in the slow construction of needed dwellings and factories and especially in the decline of shipbuilding and of our merchant marine. The tonnage clearance of American vessels engaged in foreign trade from our own ports fell from over 6,000,000 in 1860 to less than 3,500,000 in 1866.[18]

But the country was already on the eve of an era of falling prices which was to affect both agricultural production and raw materials. By 1870, wheat, which was $1.90 a bushel in Chicago in 1866, was just above the

[15] *Cf. Scientific American*, XVIII, 57–58, Jan. 25, 1868.
[16] *Hunt's Merchants' Magazine*, LVII, 419–421, Dec. 1867.
[17] *Cf. Scientific American*, XVI, 34, Jan. 14, 1867.
[18] *Scientific American*, XV, 402, Dec. 15, 1866.

dollar mark.[19] Cotton, which was 34 to 36 cents a pound in the New York market late in 1866, declined to less than 15 cents a pound at Liverpool when the following year's crop reached British markets.[20] Europe was feeling the effect of the era of Continental and foreign wars which started with the siege of Sevastopol and terminated with the siege of Paris; and contemporary comment suggests conditions resembling those which we are witnessing at the conclusion of the recent world war.

"An immense proportion of the civilized world has been kept under arms and literally millions have been slaughtered or so disabled as to become a burden to the community. While production has been curtailed to a very material extent through this severe thinning in the ranks of the producers, and industry has been diverted to the construction of stupendous navies, and the production of a thousand new appliances of warfare, national debts have been augmented and the burden of taxation made more oppressive."[21]

Another temporary wave of pessimism swept through the American business world in 1869. Merchants reported that pressure for credit was increasing and collections were becoming more difficult. Manufacturing profits did not encourage expansion. The gains from agriculture, manufacturing and trade were less than usual, except perhaps in the South, which was producing more and spending relatively less than before the war. Bank rates ranged from 10 to 12 per cent. Grain receipts at Chicago were below the average.[22] In the autumn of 1869 it was reported that there was an idle mill in nearly every manufacturing village of New England. Scores and hundreds of operatives were unemployed. Some factories were running half time. Rents were falling and, to quote a contemporary account, "a feeling of depression is insensibly creeping over the minds of business men."[23] Yet, according to other contemporary reports, "wherever we go in agricultural districts or in manufacturing centers there is offered to the eye the same evidence of new investments of capital in productive enterprises."[24] Indeed, some ascribed the stringency of the money market to the excessive conversion of floating capital into fixed capital.[25] Upon the whole, such pessimism as we have just described was temporary and local. Considered broadly, the eight years following the conclusion of hostilities were a period of almost feverish industrial expansion. Some of this was artificial and unhealthy. According to an estimate made in 1869, 28 of the leading railroads of the country had increased their combined

[19] American Iron and Steel Association, *Bulletin*, XIII, 33, Jan. 8, 1879; *cf.* however, *id.*, VIII, 259, Sept. 3, 1874.

[20] *De Bow's Review*, Post Bellum Series, III, 63, Jan. 1867; *Hunt's Merchants' Magazine*, LVIII, 361, May 1868.

[21] *Hunt's Merchants' Magazine*, LIX, 128–129, Aug. 1868.

[22] *Commercial and Financial Chronicle*, VIII, 519, Apr. 24, 1869; *Scientific American*, XX, 347, May 29, 1869.

[23] *De Bow's Review*, Post Bellum Series, VI–VII, 1077, Dec. 1869.

[24] *Commercial and Financial Chronicle*, VIII, 805, June 26, 1869; *Hunt's Merchants' Magazine*, LIX, 140, Aug. 1868; LIX, 314, Oct. 1868.

[25] E.g. *Commercial and Financial Chronicle*, XII, 551, May 6, 1871.

capitalization within two years from $287,000,000 to $400,000,000 without sound justification.[26] Though money might be scarce at times, America's credit was excellent abroad. The cash value of the American securities marketed in London 1871 was estimated at $110,000,000. German investments in American enterprises were supposed to be from $15,000,000 to $20,000,000 annually.[27] America's exports remained almost stationary and the capital we procured from Europe was a net addition to our foreign obligations. We were aided in procuring financial assistance from Great Britain at this time both by the declining premium on gold, and by business stagnation abroad, which lessened London's opportunities for investment nearer home.[28]

The South had to pass through a long and toilsome course of business reconstruction. Immediately after the conclusion of hostilities there was a brief revival encouraged, as already mentioned, by a movement of northern settlers to that region and by the fancy that the abolition of slavery would be accompanied by an economic renaissance. These hopes were speedily disappointed. But there were certain favorable factors in the situation. During the war while Confederate currency was abundant, many of the planters paid their debts. After the war it was very difficult to borrow money on the security of southern lands. Planters were therefore forced to depend on their own resources and the old credit system seemed for the moment to have disappeared. More corn and wheat and bacon were produced than previously, and there was a smaller debt balance than ever before to be deducted from the proceeds of the cotton crop. It was estimated in 1869 that the planters of the South would net $250,000,000 that year from cotton alone. There were no more negroes to buy and with the labor situation so uncertain, most planters were not anxious to increase their holdings. Consequently they were disposed to spend their money for farm implements, household furniture, and articles of comfort and luxury of which they had been deprived for so many years. So at a time when the western market was dull on account of the low price of bread stuffs, the South was prosperous and afforded a larger outlet for the northern manufactures than ever before in its history.[29]

[26] *Scientific American*, xx, 373, June 12, 1869.
[27] *Commercial and Financial Chronicle*, xvi, 78, Jan. 18, 1873.
[28] *Hunt's Merchants' Magazine*, lxii, 166–167, Mar. 1870.
[29] *Scientific American*, xx, 7, Jan. 1, 1869; *De Bow's Review*, Post Bellum Series, vi–vii, 124, Feb. 1869; *Hunt's Merchants' Magazine*, lxi, 364, Nov. 1869; *Atlantic Monthly*, xxxix, 679, June, 1877.

CHAPTER VII

IRON AND STEEL MAKING

THE ORE TRADE

A rapid expansion of the ore trade as a distinct function in the process of iron making characterized the period of activity that followed the Civil War. The manufacture of Bessemer steel created a demand for special qualities of iron, which could only be made, or could be made more economically, from western ores; and influences were already operative that were destined to shift the center of iron production westward of the Alleghenies.

Between 1850 and 1856, Lake Superior ores were used experimentally in Pennsylvania both for smelting in combination with local ores and for lining puddling furnaces.[1] During the next ten years a trade in these ores sprang up through Cleveland which encouraged the erection of furnaces and the development of iron manufactures in the Mahoning Valley. By the close of the war, therefore, they had become a staple commodity among iron makers at Lake Erie ports and inland as far as Pittsburgh. Then came the discovery that they were peculiarly adapted for making Bessemer pig. Even without this special incentive the growth of this trade would have been rapid and permanent, for the Lake Superior region soon proved the most abundant and cheapest source of ore supply for the fuel-producing district within which the metallurgical industries west of the Alleghenies had already centered.

Meanwhile, in response to the encouragement which this new demand afforded, facilities for transporting ore were rapidly improved. A canal around the Falls of Sault Sainte Marie had been opened in 1855, obviating reloading at this point. The first all-water shipments of ore from Marquette to Cleveland were made in August of that year. Ten years later the largest cargo ever brought down the Lakes was 337 tons.[2] By 1868 the maximum cargo was 821 tons.[3] In 1870 steam barges began to be employed in the ore trade between Escanaba and Buffalo. The first barges on this route carried 1,400 tons and towed 1,000 tons more, reducing the cost of water transportation between those points to about a dollar a ton.

[1] American Iron and Steel Association, *Bulletins*, xxv, 210, July 22, 1891; xli, 29, Mar. 9, 1907, and 36, Apr. 1, 1907; *cf. id.* xi, 44, Feb. 14, 1877; xxi, 98, May 1, 1897.
[2] American Iron and Steel Association, *Bulletin*, xxxix, 107, July 15, 1905.
[3] *Scientific American*, xix, 342, Nov. 25, 1868.

This marked the beginning of the rapid decline of the sailing vessel in this traffic.[4] Three years later the Marquette ore fleet consisted of 5 steamers, 6 barges, 4 tugs, and 40 sailing craft, with an aggregate burthen of a little more than 51,000 tons. At this time ore schooners were loaded with wheelbarrows and unloaded with tubs handled by a block and tackle fastened to the rigging, a system which remained in use until the middle eighties.[5] So rapid was the growth of this business that in spite of the rapid increase of tonnage, limited transportation and dock facilities continued, up to the panic of 1873, to embarrass furnace operators in the East. In 1873 a trainload of ore was shipped from Marquette to Columbus, Ohio, but this method of transportation was apparently never used except experimentally.[6]

During the period when the trade was becoming established, Lake Superior ore was used mainly for mixing with the local ores of the Mahoning Valley and western Pennsylvania. Soon, however, the demand for Bessemer pig, improved furnace practice, and the adaptation of furnaces to Lake Superior ores, encouraged iron makers to employ this material exclusively. The same conditions, together with improved and cheapened transportation, caused the grouping of great pig-iron furnaces in the immediate vicinity of steel-making centers.[7]

At the same time ore was brought to Pittsburgh and lower Ohio furnaces from Missouri. During the summer of 1868 more than 72,000 tons of Iron Mountain ore were shipped to furnaces on the Ohio River.[8] In 1871 Pittsburgh furnaces imported 35,000 tons from the Iron Mountain district and 48,000 tons from Lake Superior. By 1873 these quantities had risen respectively to 113,000 tons from Missouri and 203,000 tons from northern Michigan.[9] In 1872 the Iron Mountain mines alone shipped eastward 270,000 tons of ore, and the following year nearly 350,000 tons passed through St. Louis.

Simultaneously the iron resources of the South began to attract national attention. Hardly explored before the Civil War, except in the vicinity of a few local furnaces and forges supplying neighborhood markets, the mines of Alabama had, as we have seen, proved a main reliance of the Confederacy for ordnance, shot and shell. Many of the wartime furnaces and iron works destroyed by the Union army were never rebuilt, partly because mine owners anticipated a quicker return upon their capital from shipping ore to northern furnaces. This trade started in 1872 and continued only about three years. During the brief interval, however, considerable quantities of iron ore from Tennessee, Alabama and Georgia were delivered at furnaces in Indiana and on the Ohio River.[10]

[4] American Iron and Steel Association, *Bulletin*, IV, 355, July 13, 1870.
[5] American Iron and Steel Association, *Bulletin*, VII, 421, Sept. 3, 1873; XXXIX, 107, July 15, 1905.
[6] American Iron and Steel Association, *Bulletin*, VII, 228, Mar. 19, 1873.
[7] Bridge, *Inside History of the Carnegie Steel Company*, 54–55.
[8] *De Bow's Review*, Post Bellum Series, VI–VII, 649–650, July 1869.
[9] American Iron and Steel Association, *Bulletin*, VIII, 83, Mar. 12, 1874.
[10] American Iron and Steel Association, *Bulletin*, XLI, 20, Feb. 22, 1907.

These brown hematite and red fossiliferous ores of the South, while making excellent foundry iron, were not adapted to the production of Bessemer pig. Consequently their market was limited. Furthermore, the presence of abundant and cheap fuel in the immediate vicinity of the mines made the shipment of ore to distant points unnecessary.

Pittsburgh, as the nation's greatest metallurgical center, attracted materials from every direction. Even before the war, Champlain ores were shipped to that city for lining puddling furnaces; but there is no record that they were ever used for smelting.[11] On the other hand iron making east of the Alleghenies still employed chiefly materials mined in the vicinity of the works. Bessemer ores were relatively scarce on the Atlantic slope, and the older furnaces, established long before the new process of making steel had been discovered, were not well situated to produce Bessemer pigs. Nevertheless some mines in this region yielded excellent ore for the latter purpose. In 1873 a few cargoes of ore from northern Spain and Algeria, containing about 6 per cent of manganese, were imported for employment in the Bessemer process. Both the Bethlehem and the Trenton steel works used it experimentally, and a small consignment from Bilboa was taken by the Pennsylvania Steel Company.[12] But the trade did not prove profitable and the ores were not yet considered markedly superior to those which could be procured at home.[13]

How crude the methods of handling raw materials were at this period, is illustrated by the conditions revealed at a conference held in 1870 between the coal operators and furnace owners of the Mahoning Valley. Many mine operators at this time shipped their coal to the furnaces imperfectly screened or not screened at all, thus wasting car space at a time when hauling facilities were estimated to be but two-thirds the capacity of the mines, and rendering necessary a special screening plant at the furnace itself.[14]

The westward trend of iron making after the introduction of the Bessemer process, though not altogether on account of that improvement, is emphasized by the statistics of production. In 1856 less than 1 per cent of the iron made in the United States was produced from Lake Superior ore. In 1860 the proportion had risen to 9 per cent and in 1869 to 24 per cent.[15] It was not until 1860 that the ore output of this region exceeded 100,000 tons. In 1873 the quantity shipped from Lake Superior was 1,179,000 tons, in addition to which more than 71,000 tons of pigs were produced in local furnaces.[16]

[11] American Iron and Steel Association, *Bulletin*, XLI, 29, Mar. 9, 1907.

[12] American Iron and Steel Association, *Bulletin*, VII, 387, Aug. 6, 1873, VII, 405, Aug. 20, 1873; VII, 501, Nov. 19, 1873.

[13] American Iron and Steel Association, *Annual Report of Secretary, 1875*, 17; *cf. Bulletin*, IX, 308, Oct. 15, 1875; *Van Nostrand's Eclectic Engineering Magazine*, XI, 168–169, Aug. 1874.

[14] American Iron and Steel Association, *Bulletin*, V, 174, Feb. 4, 1871.

[15] American Iron and Steel Association, *Bulletin*, IV, 355, July 13, 1870.

[16] American Iron and Steel Association, *Bulletin*, VIII, 45, Feb. 5, 1874.

Ore prices were already based on Cleveland deliveries. Quotations at that point ranged between $7.50 and $13 a ton, the maximum price being reached just before the panic of 1873. Iron Mountain ores were delivered at St. Louis for $10 a ton.[17]

The increase in ore output was not entirely confined to the region west of the Alleghenies. Between 1864 and 1871 the quantity mined in New Jersey approximately doubled, rising from 226,000 tons to about 450,000 tons, of which more than four-fifths came from Morris County.[18] Yet the eastern mines, although their management was centralized and improved, produced but a fraction of the output of the great mines of the Northwest.

BLAST FURNACES IN THE NORTH

During the maximum iron demand, just before the panic of 1873, measures were taken to reopen the old Katahdin iron works in Maine. New furnaces were built in northern New York, at least one of which planned to use Canadian ore. During this period we begin to hear of blast furnaces, located in large cities or their immediate vicinity, another testimony to the increasing cheapness of transportation. In 1873 such a furnace was built in Philadelphia.[19] The same year Pittsburgh, which during the first half of the century was a center of reproductive rather than primary iron manufacturing, had 11 blast furnaces, producing altogether 3,200 tons of pig a week.[20] A similar development occurred at Chicago, St. Louis, Milwaukee and Indianapolis.

During these years charcoal-iron makers, even though they maintained their output at its former level, lost ground relatively to the industry as a whole. The old charcoal furnace districts in eastern Pennsylvania and Maryland began to decline, as did likewise another old iron-making region in the Hanging Rock district of Kentucky and Ohio, where there were at the close of this period some 61 furnaces,[21] of which 44 used charcoal. Practically all of the 41 furnaces, which at various times had been in operation along the Cumberland River in Tennessee and Kentucky, were out of blast before 1873.[22] The charcoal-iron industry of Michigan and Wisconsin, which had attained moderate proportions during the Civil War, continued to thrive as long as timber was plentiful in the vicinity of the works. With the depletion of the forests efforts were made to smelt ore with peat.[23] The principal reason for the relative decline of charcoal smelting was the increased scarcity and cost of fuel. Furthermore improvements in

[17] American Iron and Steel Association, *Bulletin*, VII, 148, Jan. 8, 1873.

[18] American Iron and Steel Association, *Bulletin*, VI, 290, May 15, 1872.

[19] American Iron and Steel Association, *Bulletin*, VII, 179, Feb. 5, 1873; VII, 259, Apr. 16, 1873; VII, 530, Dec. 20, 1873.

[20] American Iron and Steel Association, *Bulletin*, VIII, 83, Mar. 12, 1874.

[21] Kentucky, *Reports of the Progress of the Geological Survey*, 1876: New Series, vol. I, 320–321.

[22] American Iron and Steel Association, *Bulletin*, XV, 324, Dec. 21, 1881.

[23] American Iron and Steel Association, *Bulletin*, IV, 353–354, July 13, 1870; V, 423, Sept. 6, 1871; VI, 298–299, May 22, 1872; VII, 74, Nov. 6, 1872; VII, 157, Jan. 15, 1873; VII, 446, Sept. 24, 1873; VII, 467, Oct. 22, 1873; *Van Nostrand's Eclectic Engineering Magazine*, IV, 574, June, 1871.

metallurgical processes, and especially the growing employment of Bessemer steel, deprived charcoal iron of part of its former market.

In the East iron expansion centered in the anthracite region of eastern Pennsylvania, notably in the Lehigh Valley. During 1871 the 38 blast furnaces of this district made nearly 380,000 tons of pigs, and three furnaces with a combined capacity exceeding that of all the 11 charcoal furnaces in the state of Maryland were in course of construction.[24]

Shortly after the Civil War, the discovery that Indiana possessed an unexpected abundance of coking coal encouraged capitalists to erect several blast furnaces in the vicinity of Indianapolis and Terre Haute.[25] These used mainly Missouri and Lake Superior ores, although some ores from local deposits were employed experimentally. But what for a time seemed to be the most promising iron-making center of the West was Carondolet, about 6 miles south of St. Louis, where important works were erected in 1868 and 1869 to smelt Missouri ores with Illinois coke and coal, and to convert the product directly into finished shapes.[26] The association of smelting furnaces with steel works and rolling mills had now become more common. Sometimes, as at Carondolet, they were erected simultaneously,[27] but more frequently manufacturers consuming large quantities of iron later added blast furnaces to their existing plants.

This development was regarded as so important that it was argued in 1873 that St. Louis might become a serious rival, and indeed might eventually supplant Pittsburgh as the great iron-making center of the United States. The Missouri metropolis was thought to have better ore within easy access than Pittsburgh; and while the Pennsylvania city had an established iron trade and all the advantages of long years of manufacturing experience, St. Louis was many hundreds of miles nearer to western consumers. Of course practical iron makers realized that the presence of suitable coal cheaply mined and in practically inexhaustible quantities was the determining influence in deciding the localization of great metallurgical industries, and that in this respect Pittsburgh had a marked advantage over any western competitor, but the debate illustrates a prevailing attitude of mind toward the future manufacturing possibilities of the West. St. Louis did, indeed, build up rapidly a promising iron and steel industry, and had it not been for the unexpected exhaustion of the Iron Mountain and Pilot Knob ores, that city might have remained an important primary iron-making center.[28]

[24] American Iron and Steel Association, *Bulletin*, VI, 99, Nov. 29, 1871.

[25] American Iron and Steel Association, *Bulletin*, VI, 185, Feb. 14, 1872; VII, 114, Dec. 13, 1872; *Van Nostrand's Eclectic Engineering Magazine*, VII, 219–220, Aug. 1872.

[26] *Scientific American*, XVIII, 278, May 2, 1868; *De Bow's Review*, Post Bellum Series, VI–VII, 646, July 1869; *id.*, 752–753, Sept. 1869; American Iron and Steel Association, *Bulletin*, II, 370–371, July 28, 1868; III, 123, Dec. 23, 1868; III, 314, June 9, 1869; III, 338, June 30, 1869; III, 345, July 7, 1869; III, 394–395, Aug. 18, 1869; V, 295, May 17, 1871; VII, 114, Dec. 13, 1872.

[27] *Cf.* King, *The Great South*, 238; *Van Nostrand's Eclectic Engineering Magazine*, I, 189, Feb. 1869.

[28] American Iron and Steel Association, *Bulletin*, VII, 228, Mar. 19, 1873; VII, 243, Apr. 2, 1873.

One effect of the growing ore trade on the Great Lakes was to revive interest in iron-making at Buffalo, where furnaces erected a decade or more before had been but languidly prosperous. Furnaces were also erected accessible to the Erie Canal at Rochester and Syracuse.[29] As we shall see later, the old iron industry of Troy was so stimulated by the early introduction of the Bessemer process there, that it became for a brief period a blast furnace center.

In 1868 a company was organized to build two blast furnaces in Chicago, to use Lake Superior ore and the recently developed coal from central Illinois. These furnaces began producing in 1869, and made their initial blast with eastern coke.[30] Chicago was already a large iron-consuming city, on account of its extensive agricultural implement works and machine shops, which were said even at that time to employ 15,000 men.[31] But the great market for iron, from the quantitative standpoint at least, still came from the railway builders; and it was the rapid increase of western mileage during the boom years preceding the panic of 1873 that gave most encouragement to furnace building in that region.

Farsighted iron men already foresaw that with cheap water carriage via the Great Lakes, and especially with ore boats returning to the western mines with practically empty holds, it would eventually prove profitable to erect furnaces on the Upper Lakes. In 1871 arrangements were made to build a furnace to employ anthracite or bituminous coal at Marquette.[32] By this time the furnaces of the Upper Peninsula were blowing out permanently because timber for making charcoal was exhausted in their vicinity. But the real development of western iron-making awaited the successful employment of the coking coals mined in the adjacent states.

Charcoal iron had been manufactured in Wisconsin since 1849.[33] Before 1870 several charcoal furnaces were built at different points, mostly in the northern part of the state;[34] but the largest works were erected at Milwaukee and used a mixture of coke and anthracite. They employed southern Wisconsin and Lake Superior ores in about equal proportions. These furnaces drew their fuel from the bituminous fields of Ohio, the anthracite mines of Pennsylvania, and the coke ovens of Connellsville. Coke was brought by rail, coming as a back load in stock cars; and coal was also a back load, being carried by grain vessels.[35]

[29] American Iron and Steel Association, *Bulletin*, III, 169, Feb. 3, 1869; III, 345, July 7, 1869; V, 75, Nov. 9, 1870, VII, 171, Jan. 29, 1873; VII, 259, Apr. 16, 1873.

[30] *Scientific American*, XVIII, 246, Apr. 18, 1868; American Iron and Steel Association, *Bulletin*, III, 139, Jan. 6, 1869.

[31] *Scientific American*, XIX, 390, Dec. 16, 1868.

[32] An older furnace at this point was designed to use coal: American Iron and Steel Association, *Bulletin*, III, 217, Mar. 17, 1869; VI, 41, Oct. 12, 1871.

[33] Swank, *Iron in All Ages*, 329; American Iron and Steel Association, *Bulletin*, VI, 153, Jan. 17, 1872.

[34] American Iron and Steel Association, *Bulletin*, I, 41, Oct. 17, 1866; III, 169, Feb. 3, 1869; IV, 170, Feb. 2, 1870; VI, 42, Oct. 12, 1871.

[35] American Iron and Steel Association, *Bulletin*, IV, 41, Oct. 13, 1869; V, 309, May 31, 1871; VII, 147, Jan. 8, 1873; VII, 229, Mar. 19, 1873.

BLAST FURNACES IN THE SOUTH AND FAR WEST

Iron making was resumed in a small way by southern iron masters immediately after the cessation of hostilities, and indeed some furnaces may have continued in operation without interruption. Transactions in Virginia furnace property were recorded in 1867.[36] Two years later a peculiar enterprise was promoted in North Carolina, known as the Central Steel and Iron Manufacturing Company. The directors planned to erect ten Catalan forges, presumably for the wholesale production of blooms, but the enterprise never realized its ambitious hopes.[37] At least three furnaces were operated in South Carolina during the Civil War. The companies owning them were bankrupted by the emancipation of their slaves and the vanishing value of the Confederate securities which they had received in payment of work done for the Southern Government;[38] and after 1865 South Carolina ceased to be an iron-producing state. Georgia had five charcoal furnaces in blast by 1870.

But the speediest and most promising resumption of iron making in the territories of the former Confederacy was in southern Tennessee and northern Alabama. The growth of the industry around Chattanooga was due in part to the development of the so-called "dye stone belt" of ore, discovered by General John T. Wilder, of Ohio, during his campaign under Rosecrans. In 1867 he founded the Roane Iron Company, in association with Indiana and Ohio capitalists, and erected a small coke furnace near Nashville. During hostilities a Government rolling mill had been operated by the Federal forces at Chattanooga. This was purchased by the same company and the nucleus was thus formed for a group of corporations which were eventually to play an important part in the iron and steel industry of the South.[39]

Wilson's cavalry campaign, in 1865, left the furnaces of Alabama in ruins. But the owners, in most cases with the assistance of Northern capital, immediately set about restoring their property. The first works to resume operations were the Irondale Furnace, near the present site of Birmingham, which was entirely rebuilt and went into blast early in 1866.[40] The Cornwall and the Briarfield works followed in 1867 and 1868, respectively.[41] Birmingham was founded in 1871, though not primarily as an iron and coal city, and the furnace that formed the nucleus of the future town of Anniston was completed two years later.[42] Indeed the iron makers of the United

[36] American Iron and Steel Association, *Bulletin*, II, 10, Sept. 18, 1867.

[37] American Iron and Steel Association, *Bulletin*, III, 297, May 26, 1869.

[38] American Iron and Steel Association, *Bulletin*, XXVII, 9, Jan. 11, 1893.

[39] King, *The Great South*, 533; American Iron and Steel Association, *Bulletin*, III, 115, Dec. 16, 1868; XVII, 233, Aug. 29, 1883; *Manufacturers' Record*, LXVI, 41–42, Nov. 26, 1914.

[40] American Iron and Steel Association, *Bulletin*, I, 129, Jan. 2, 1867; Armes, *The Story of Coal and Iron in Alabama*, 196–197.

[41] *Scientific American*, XVI, 378, June 15, 1867; *id.* XVI, 199, Mar. 30, 1867; Armes, *The Story of Coal and Iron in Alabama*, 204–207; American Iron and Steel Association, *Bulletin*, I, 246, Apr. 3, 1867; VIII, 124, Apr. 16, 1874; Somers, *The Southern States*, 173–175.

[42] American Iron and Steel Association, *Bulletin*, VIII, 9, Jan. 8, 1874; XVI, 37, Feb. 1, 1882; XXI, 169, June 29, 1887; XXX, 153, July 10, 1896; Armes, *The Story of Coal and Iron in Alabama*, 242.

States were just becoming aware of the mineral wealth of this district when the panic of 1873 put a temporary stop to further projects of expansion.[43]

Although foundries and rolling mills were in operation in California, no iron ores were smelted in the Rocky Mountain region or on the Pacific Coast before 1873, except for a very brief period during the Civil War at a small charcoal furnace at Langford, Colorado, and at a point on the Columbia River in the vicinity of Portland, where a furnace was erected in 1866 which produced iron intermittently for several years. Part of its product was shipped to San Francisco.[44]

BESSEMER STEEL

During the war decade the manufacture of low-carbon steels was successfully introduced into the United States, an event that, like the introduction of the hot blast and the anthracite smelting furnace a generation earlier, marked the beginning of a new era in the history of our metallurgical industries. Some ten years before the outbreak of the war, William Kelly, an American ironmaster, had invented a pneumatic process for decarbonizing iron, which he employed in the manufacture of boiler plates. Four or five years later, Sir Henry Bessemer hit upon the same idea in England. But neither of these inventors succeeded in manufacturing steel; and, indeed, it is doubtful if William Kelly ever contemplated that possibility. Within a few years, however, improvements were made in the Bessemer process by Robert Mushet, who overcame some of the difficulties that Bessemer himself had encountered. About the same time his method was employed in Sweden with peculiarly suitable iron, and steel of fairly uniform quality was produced. Meanwhile, new progress had been made with the Kelly process.

Almost simultaneously other methods of making steel were being developed on the Continent. What was known as "steel puddling" extended rapidly in Germany about the middle of the century, and the Martin process, from which the acid open hearth method took its start, was being somewhat crudely practiced in France.

During the Civil War, the demand for improved armor and for more powerful artillery aroused unusual interest in steel-making processes in the United States. As earlier mentioned, an attempt was made to produce puddled steel at Albany, where an unusually pure iron smelted from Champlain ore was easily obtained. The crucible steel industry also expanded. About 1862 measures were taken to introduce the Kelly or Bessemer process near Detroit; but various delays, some of which were incidental to the war,

[43] American Society of Civil Engineers, *Transactions*, I, 193, Dec. 1, 1869; *Commercial and Financial Chronicle*, VII, 421–422, Oct. 3, 1868; American Iron and Steel Association, *Bulletin*, III, 378, Aug. 4, 1869; IV, 474, Feb. 23, 1870; V, 309, May 31, 1871.

[44] Swank, *Iron in All Ages*, 343; American Iron and Steel Association, *Bulletin*, XIX, 282, Oct. 21 and 28, 1885; *cf. id.* I, 422, Sept. 4, 1867; II, 34, Oct. 9, 1867; II, 42, Oct. 16, 1867; II, 377, Aug. 5, 1868; VII, 523, Dec. 10, 1873; XXII, 361, Dec. 12, 1888; XLIV, 35, Apr. 15, 1910.

postponed the completion of the experimental plant until 1864, when the first Bessemer steel produced in America was made at Wyandotte.[45] At the same time the firm which had built the *Monitor*—stimulated perhaps by the suggestion of the Assistant Secretary of the Navy—was also preparing to make Bessemer steel, and this metal was first produced at Albany early in 1865.[46] Although both of these experimental works copied, as far as they were able, the apparatus and the process used in England, where the industry was by this time well established, the builders accommodated their plants to American conditions, and from the outset introduced modifications in their equipment which continued to characterize the American industry.

Even though our pioneer steel manufacturers had the experience of England and Sweden to draw upon, nevertheless they had to learn from practical experience the lessons which earlier failures had already taught steel makers abroad. The first chemical labratory attached to any metallurgical works in the United States was established at the Wyandotte furnace in the spring of 1863, preparatory to the experiments we have just mentioned.[47] Such lack of success as attended the experimental manufacture of Bessemer steel in America—which covered roughly the first five years of the industry in this country—was due mainly to imperfect control of the raw materials employed.[48] Spiegeleisen, a residuum of iron, manganese, silicon, lime, zinc and magnesia, which formed a by-product in the manufacture of zinc paints in New Jersey, was used as a "re-carbonizing metal," and from the first the indirect process was used.[49] The successful outcome of the experiments at Wyandotte and Troy was doubtless due to the purity of the iron employed. The converter at the former plant was supplied with iron smelted from what were later known as the Bessemer ores of Lake Superior, and at the latter with iron of equal quality from the Champlain furnaces. The importance of a suitable pig iron was recognized at Wyandotte, for the persons operating the works arranged to receive sample charges from several different furnaces for use in their experiments.[50]

Pennsylvania, destined speedily to become the most important steel-producing state, as it already was the largest manufacturer of pig-iron and finished metal products, did not adopt the process until 1867, when the Pennsylvania Steel Company erected a Bessemer converter in its new works near Harrisburg. A second establishment, which never became a regular producer, was built near Lewistown and began to make steel in 1868. This was the only enterprise of the kind to fail entirely, its works being sub-

[45] American Iron and Steel Association, *Bulletin*, XVIII, 291, Nov. 12, 1884.
[46] American Iron and Steel Association, *Bulletin*, XIII, 186, July 23 and 30, 1879; XVIII, 298, Nov. 19, 1884.
[47] American Iron and Steel Association, *Bulletin*, XXX, 249, Nov. 10, 1896.
[48] American Iron and Steel Association, *Bulletin*, VI, 185, Feb. 14, 1872; XL, 12, Jan. 20, 1906; *Van Nostrand's Eclectic Engineering Magazine*, VI, 554–556, May, 1872.
[49] American Iron and Steel Association, *Bulletin*, VII, 413, Aug. 27, 1873.
[50] American Iron and Steel Association, *Bulletin*, XVIII, 291, Nov. 12, 1884.

sequently dismantled. These pioneer enterprises were followed by the Cambria Iron Company, which made its first steel in 1871, and the Bethlehem Steel Company, which became a producer in 1873, ten years after its rolling mills went into operation.[51] Meanwhile the industry was spreading westward. Bessemer steel was made at Newburgh, Ohio, in 1868.[52] By 1873 two steel works were in operation at Chicago and one at Joliet.[53]

During this initial period American Bessemer steel makers encountered the difficulties which usually face pioneers. Their undertakings earned little or no profits, although they represented very large investments for the day. The steel they made was not uniform. There was a large percentage of waste. And last but not least, potential consumers were skeptical as to the value of the product. It was early recognized that the largest demand would be for rails, and as late as 1868 experts argued that though Bessemer steel would last longer than iron, "it is comparatively easy to make the toughest steel brittle by cold hammering." An iron rail would retain its fibrous character until so worn as to require replacement, but a steel rail might from its superior resistance to wear, to which was added the possibility of an inferior resistance to the crystallizing process, be in an unsafe condition internally while presenting a fair external appearance. Indeed, some engineers predicted that the principal use of the new steel would probably be in structural work, such as bridges and buildings and in vessels, where its greater tensile strength enabled lighter sections to be employed.[54]

Manufacturers not only faced an uncertain market, but they experienced great difficulty in obtaining suitable pig iron and materials for lining their converters. For a time some of them fell back on European experience, and large quantities of Bessemer pig were imported.[55] The lack of skilled workmen was also seriously felt. Indeed America was still far behind Europe and Great Britain in this industry. In his report on the Paris Exposition of 1867, Abram S. Hewitt said:

> "In view of the small amount of Bessemer steel as yet produced in the United States, we are struck in Europe with surprise at the enormous provision made for its supply; and it is quite evident that the business is overdone, and, contrary to all past experience, the inventor and the public at large seem to have profited by its introduction at the expense of the manufacturer."

[51] American Iron and Steel Association, *Bulletin*, XVI, 325, Dec. 6, 1882; XXXVIII, 133, Sept. 10, 1904; *Scientific American*, XVII, 166, Sept. 14, 1867; *Van Nostrand's Eclectic Engineering Magazine*, I, 280, Mar. 1869; I, 593, July 1869; I, 887, Oct. 1869; I, 1045, Nov. 1869; I, 1137, Dec. 1869; V, 331, Sept. 1871.

[52] American Iron and Steel Association, *Bulletin*, III, 27, Sept. 30, 1868.

[53] *Scientific American*, XX, 29, Jan. 9, 1869; American Iron and Steel Association, *Bulletin*, VII, 156, Jan. 15, 1873; VII, 180, Feb. 5, 1873; VII, 217–218, Mar. 12, 1873; VII, 357, July 9, 1873; VII, 477, Oct. 29, 1873; VIII, 218, July 16, 1874; *Van Nostrand's Eclectic Engineering Magazine*, V, 438, Oct. 1871.

[54] *Scientific American*, XVIII, 25–26, Jan. 11, 1868; *cf.* Flint, *The Railroads of the United States*, 424–425; *Journal of the Franklin Institute*, LXIV, 252–265, Nov. 1872; 391–399, Dec. 1872; LXV, 233–241, Feb. 1873.

[55] American Iron and Steel Association, *Bulletin*, XL, 12, Jan. 20, 1906.

Yet, the same expert predicted that:

"The Bessemer process will not, as Mr. Bessemer supposed, supersede the puddling process, which appears to be, as yet, the only method applicable to the conversion of by far the larger portion of the pig iron made into wrought iron."[56]

Mr. Hewitt himself introduced the open-hearth method in the United States. Utilizing his observations in Europe during the Paris Exposition, he began to manufacture steel at Trenton by the acid process in 1868. But, as in the case of the Bessemer process, European practice was modified in the United States, grey pig iron being employed in place of *spiegeleisen* for the bath, into which was fed "puddling steel," anthracite, pig and steel scrap from the Bessemer furnaces. Indeed, the latter soon became the principal ingredient. The open-hearth product was used largely for locomotive boiler plates, for which it was reported to be admirably adapted, as it was a much softer steel than could be produced by the Bessemer method. It was also dearer than the latter.[57]

CRUCIBLE STEEL

Although the production of crucible steel increased rapidly during the Civil War, especially at Pittsburgh and Jersey City, the quality of the product was still uncertain. A critic wrote in 1866:

"Some of it is so hard that it will not bear more than a dull red heat, and then, when hardened, will break when driven into a piece of hard wood."[58]

This was due to carelessness or lack of skill in selecting materials. Swedish iron was imported by some makers. In 1870 the Siemens regenerative furnace, which had been introduced at Pittsburgh in 1863 for refining copper and making glass, began to be used by the crucible steel makers of that city. This resulted in a large saving of fuel and placed the industry on a more assured and profitable basis.[59]

In 1868 American producers made 30,000 tons of steel, of all varieties, of which 8,500 tons were Bessemer.[60] Five years later 178,000 tons were manufactured including 140,000 tons of Bessemer steel, 85 per cent of which was converted into rails. Seven open-hearth plants were in operation, but they made in the aggregate only a few thousand tons. The eight producing Bessemer works were larger affairs, and were located at Troy, Johnstown, Harrisburg, Bethlehem, Newburg, Joliet and Chicago, where there were two separate establishments.[61] Pittsburgh did not make Bessemer steel until after 1874.

[56] United States Commissioners to the Paris Exposition, 1867, *Reports*, II, 31.

[57] American Iron and Steel Association, *Bulletin*, IV, 306, June 1, 1870; XXXVII, 12, Jan. 25, 1903; *cf.* however, Butler, *Fifty Years of Iron and Steel*, 71–72.

[58] *Scientific American*, XV, 187, Sept. 15, 1866.

[59] American Iron and Steel Association, *Bulletin*, XXXIV, 49, Mar. 10, 1900; *Van Nostrand's Eclectic Engineering Magazine*, I, 949, Oct. 1869; VIII, 112, Feb. 1873; VIII, 475–476, May 1873.

[60] American Iron and Steel Association, *Bulletin*, III, 210, Mar. 10, 1869.

[61] American Iron and Steel Association, *Bulletin*, VII, 499, Nov. 19, 1873; IX, 268, Sept. 3, 1875; X, 156, May 24 and 31, 1876.

CHAPTER VIII

IRON AND STEEL MANUFACTURING

RAILWAYS AND RAIL MAKING

Our metallurgical industries were first and foremost the handmaids of transportation. During the early decades of the century, foundries and shops for the manufacture of steamboat machinery were to be found at every important river town of the interior, while larger engine works were established at our leading seaports. Indeed, the period when steam was applied exclusively to water transportation might be called the foundry era of the American iron industry. Then came railways and with them the rapid development of the rolling mill. Thereafter, for most of the remainder of the century the market for rails was the barometer which measured the prosperity or depression of iron and steel manufacturing.

Within five years of the date when Bessemer steel was first produced in America, it was generally recognized that this metal was destined to displace iron, not only upon railways but wherever iron had previously been employed for structural uses. Although the **T** rail had by this time been generally adopted, the railway iron of the Civil War period was different in weight and pattern from that used today. Prior to 1864 no western roads, at least, had rails more than 25 feet long, while those of 21-foot and even 18-foot dimensions—the maximum lengths that most mills could roll at a single heat—were common. Fish-plates were just beginning to be used and their value was but imperfectly appreciated. In 1866 the general manager of a prominent western railway expressed the opinion that the chief value of fish-plates was to anchor bridges; for on his line bridges crossed by rails united by fish-plates remained on their abutments after a recent flood, but the others sailed down stream.[1] By the end of the decade the practice of sampling and testing each converter lot of steel and each ingot was followed in some works.[2] The usual weight of rails at this time was 56 pounds a yard.[3]

[1] American Iron and Steel Association, *Bulletin*, XXVIII, 194, Sept. 5, 1894.

[2] American Iron and Steel Association, *Bulletin*, IV, 41, Oct. 13, 1869; *Commercial and Financial Chronicle*, IX, 528, Oct. 23, 1869; *cf.* also American Iron and Steel Association, *Bulletin*, VII, 493, Nov. 12, 1873.

[3] *Scientific American*, XVIII, 310, May 16, 1868; American Iron and Steel Association, *Bulletin*, III, 179, Feb. 10, 1869.

The eight years between the restoration of peace and the panic of 1873 were a period of rapid railway building. Prior to the Civil War the year of maximum construction was 1856, immediately before the previous panic, when over 3,600 miles of new line were built. This remained the record until 1869, when there was a sudden jump to 7,745 miles of new construction, which was approximately equivalent to the entire railway mileage of the country 20 years before. During the four years beginning with 1869, nearly 25,000 miles of new line were built, adding considerably more than 50 per cent to the country's previous mileage.[4]

Capital for these new roads and extensions of old roads was partly found abroad, and came to this country to no small extent in the form of Bessemer rails. Between 1865 and 1870 British rail exports to this country rose from 63,000 to 472,000 tons a year. We also received some steel rails from France and Prussia.[5] These imports continued to increase until shortly before the panic.

The first American Bessemer rails were rolled at Chicago in May 1865, at the time the American Iron and Steel Association was meeting in that city. The steel was produced at the Wyandotte works near Detroit.[6] This incident calls attention to the important influence sometimes exercised upon a great industry by a single individual. Captain Eber B. Ward, an iron manufacturer of Detroit and promoter of the steel works at Wyandotte, had operated at the latter point one of the earliest rail mills in the West. In 1858 he completed mills in northern Chicago to re-roll rails for the railroads centering in that city. Later he became interested in the iron works at Milwaukee. This group of enterprises, each of which was operated independently, but all of which owed their origin or success largely to the enterprise of a single individual, did much to give character to the iron and steel industry of the West for the next twenty years. Indeed, the great steel industry at the head of Lake Michigan may be said to have had its beginning at this time. In 1870, immediately after the completion of two blast furnaces erected the previous year, the North Chicago Works decided to add a Bessemer plant to their establishment. The work was interrupted by the great fire, but in April 1872, the first Bessemer steel was produced in Chicago, and from that time dates the rapid expansion of steel manufacturing in the West.[7]

Meanwhile the works at Troy, and others in Pennsylvania, began to roll steel rails. They were first made commercially in 1867, when the product was slightly over 2,000 tons. Two years later American mills rolled more than 8,000 tons. New works brought the product up to 30,000 the follow-

[4] American Iron and Steel Association, *Bulletin*, IV, 275, May 4, 1870; VII, 477, Oct. 29, 1873.

[5] American Iron and Steel Association, *Bulletin*, III, 99, Dec. 2, 1868; III, 281, May 12, 1869; VI, 19, Sept. 20, 1871; *Commercial and Financial Chronicle*, XXIX, 329, Sept. 27, 1879. For the poor quality of imported rails see American Iron and Steel Association, *Bulletin*, III, 163, Jan. 27, 1869; *Van Nostrand's Eclectic Engineering Magazine*, III, 128, Aug. 1870.

[6] American Iron and Steel Association, *Bulletin*, XVII, 209, Aug. 8, 1883; Swank, *Iron in All Ages*, 413.

[7] American Iron and Steel Association, *Bulletin*, XXX, 26, Feb. 1, 1896.

ing season, to 84,000 tons in 1872, and to 115,000 tons in 1873. Even the ensuing panic did not lessen the output, which increased regularly for every year of the following decade.[8] In 1873 there were seven rolling mills in the United States that manufactured Bessemer rails. Those east of the Alleghenies were at Troy, New York, and at Johnstown and Harrisburg, Pennsylvania. Ohio had one establishment at Newburg. Illinois, however, led the Union in number of steel mills, and equaled Pennsylvania in capacity, having two such establishments in Chicago and one at Joilet. Later in the year the plant at Bethlehem went into operation and the Edgar Thompson Steel Works were under construction near Pittsburgh, forecasting Pennsylvania's future precedence in this industry.[9]

THE STEEL TARIFF

With the establishment of steel works in the United States, a new phase in the relation of this industry to the tariff was inaugurated. During the first years of experiment little was heard concerning the need of protection, partly perhaps because the future of the industry was regarded as still uncertain. But as soon as the American steel rail was demonstrated to be a success a demand for a revision of duties to accord with this new situation arose. The duty at this time was 45 per cent *ad valorem* and rails cost from $90 to $100 gold a ton. After January 1, 1871, a specific duty of $28 per ton was levied in place of the older *ad valorem* duty, thus appreciably reducing the protection afforded American makers. Nevertheless the increase in domestic production exceeded the growth of imports, and although the latter rose rapidly during the era of railroad expansion, they formed a smaller percentage of the total consumption of the country in 1872 and 1873 than at any other time during this period.[10]

It must not be assumed that steel rails rapidly replaced iron rails. The economy of the former was greatest in places of heavy traffic. On sidings and frontier roads and branch lines, where traffic was light and motives existed for keeping capital investment down to the lowest point, iron rails continued for many years to be cheaper and more satisfactory. While there were 7 mills rolling Bessemer rails in 1873, there were 50 that rolled only iron rails. The latter establishments were distributed from Maine to California,[11] and nearly 7 tons of iron rails were rolled for every ton of steel rails.[12] Not only was the competition between iron and steel for railway use an unsettled issue, but some engineers and manufacturers con-

[8] American Iron and Steel Association, *Bulletin*, XIV, 36, Feb. 11, 1880.

[9] American Iron and Steel Association, *Bulletin*, VII, 293, May 14, 1873.

[10] American Iron and Steel Association, *Bulletin*, XXXV, 100, July 10, 1901; VII, 284, May 7, 1873.

[11] American Iron and Steel Association, *Bulletin*, VII, 293, May 14, 1873.

[12] American Iron and Steel Association, *Annual Report of Secretary, 1875*, 39–40. Some account of the early experiments with steel rails will be found in the *Scientific American*, XVIII, 54, Jan. 25, 1868; Massachusetts Railway Commissioners, *Report on the Subject of Steel Rails; Sen. Doc. No. 47*, 1869–70; *Journal of the Franklin Institute*, Feb. 1870.

tinued to believe that the line of improvement in rail making lay in the direction of labor-saving devices for puddling iron.[13]

SMELTING FURNACES

By 1860 furnace construction and furnace practice were in broad outline what they are today. Coke was extensively used for smelting; ores were selected and mixed with a view to producing specific qualities of iron; the hot blast and the regenerative furnace were in common use, and furnace gases were employed as fuel. Each of these improvements represented a radical advance upon what had been universal principles of furnace construction and practice two decades before. By 1860 there were record runs of 300 tons of metal a week.

During the following decade the great step forward in American metallurgy was, of course, the introduction of the Bessemer process. In 1860 all bars, rods, plates, sheets and rails were made of iron and the puddling furnace, itself still almost a novelty to veteran American iron makers, was an indispensable agency in their production. The forge, so prominent in colonial times and during the earlier decades of the Republic, had nearly gone out of existence, so far as it was employed for producing bars from pigs; although as late as 1850 there had been more pig-iron and scrap-iron forges than rolling mills in Pennsylvania. But bloomeries, or forges for making wrought iron directly from the ore, survived beyond the period we are about to describe; and as late as 1876 in New York state they still outnumbered rolling mills.[14]

During the Civil War decade western furnaces began to differentiate from those of the older smelting regions of the East. In the latter district construction continued to follow the same general design, and to employ the same materials, as in the earlier half of the century. Many stacks were built, or at least faced, with stone, and their walls were continuous from the foundation to the summit. Hot-blast stoves were still placed at the tunnel head. In the West it became customary early in the sixties to erect the most modern furnaces upon cast-iron bed plates raised some distance from the ground and supported on a cluster of pillars of the same material so close together that trusses were not needed. Upon this base was built the furnace proper, consisting of a shell of boiler iron enclosing the brick interior, as is the custom today. The water basket, or channel around the circumference of the bed plate, had already been introduced. Some improvements in the construction of the hot blast stove were made during the Civil War, but in 1867 and 1868 John Player of England introduced in this country his improved stove, which represented the most important advance of the decade in smelting apparatus. This stove was placed on the ground, the gases being conveyed from the capped tunnel-head by a pipe running down the exterior of

[13] American Iron and Steel Association, *Bulletin*, VII, 153, Jan. 15, 1873.
[14] American Iron and Steel Association, *Bulletin*, XXX, 3, Jan. 1, 1896.

FIG 1.—Early Pennsylvania Blast Furnace

FIG. 2.—Modern Blast Furnace

the furnace. With the Player stove much hotter blasts than hitherto could be secured and the diameter of the furnace could be profitably enlarged. As a result, about 1870 a decided increase occurred in the weekly output of the largest and most modern American furnaces, accompanied by a corresponding improvement and standardization of their product.[15]

England preceded us, though by only a few years, in this development, which occurred first in the famous Cleveland iron-making district of that country. Between 1863 and 1869 the height of furnaces in that region was increased from 50 to 100 feet, and the boshes were widened from 14 and 18 feet to 25 and 27 feet. Meanwhile the blast, which hitherto had been kept, as in America, at about the melting point of lead—the favorite test of old-time iron masters—or 621°, was raised to 1000° and 1200°, and maintained at that point with great regularity. So decided was the increase in output and the improvement in the quality of the iron, that old furnaces were necessarily abandoned or rebuilt, it being estimated at the time that the saving in the cost of production by the larger furnace would pay the expense of constructing it within two years. In 1869 some English furnaces produced as high as 597 tons a week.[16]

America followed closely in the footsteps of her English predecessors. In 1869 Abram Hewitt predicted that the coming furnace in this country would probably be 100 feet high with as hot a blast as the pipes would stand.[17] That year a new furnace went into operation at Newport, Kentucky, 60 feet high with a 14-foot bosh, where Player stoves producing a temperature of 1000° to 1200° were used and an elevator lifted the fuel and ore to the tunnel head. Equally high temperatures were at this time employed at a furnace on Lake Champlain. In 1872 the Lucy Furnace near Pittsburgh went into blast.[18] It was 75 feet high by 20 feet in diameter and made 475 tons of Bessemer pig in a week, which was claimed to be the record output of any furnace in the country.[19] In 1873 the Cambria Iron Company began erecting two furnaces of the same general design and capacity. At this time devices for cooling the cinder artificially were introduced.[20]

These improved furnaces, however, did not represent the average technical progress of iron-making in this country. Most American ore continued to be smelted in comparatively small furnaces with low-temperature blasts, and indeed there was a widely prevalent belief that the best iron could be made only by the older method. In the Susquehanna

[15] *Cf.* American Iron and Steel Association, *Bulletin*, III, 290–291, May 19, 1869; VI, 346, July 3, 1872; VII, 403, Aug. 20, 1873; VII, 420, Sept. 3, 1873; American Society of Civil Engineers, *Transactions*, I, 198.

[16] American Iron and Steel Association, *Bulletin*, III, 201, Mar. 3, 1869; III, 241, Apr. 7, 1869.

[17] American Iron and Steel Association, *Bulletin*, III, 201, Mar. 3, 1869.

[18] For an interesting account of the competition between these rival furnaces see Bridge, *Inside History of the Carnegie Steel Company*, 55–60; *cf. Van Nostrand's Eclectic Engineering Magazine*, I, 280, Mar. 1869.

[19] American Iron and Steel Association, *Bulletin*, VIII, 13, Jan. 8, 1874.

[20] American Iron and Steel Association, *Bulletin*, VII, 420, Sept. 3, 1873.

Valley as late as 1869 many furnaces operated with an average blast temperature of between 400° and 500°. Lehigh Valley furnaces maintained temperatures of 621°, and the famous Thomas iron was smelted with blasts above 700°. At the best Massachusetts charcoal furnaces, 612° was considered the standard.[21]

With the introduction of the Bessemer process it became necessary to control more carefully than hitherto the quality of pig iron produced. Fortunately the Lake Superior ores, which had now come to be employed extensively if not predominantly in the West, and the ores from Lake Champlain and northern New Jersey, were for the most part free from the two elements, sulphur and phosphorus, which did most to interfere with the success of the Bessemer method.

Three years after the first laboratory for metallurgical research was established at Wyandotte in 1863, preparatory to making the first Bessemer steel produced in the United States,[22] an American Iron-Masters Laboratory was opened in Philadelphia for analyzing ores. Its purpose was announced to be to encourage the development of workable bodies of iron ore and to inform producers of the quantity and quality of the metal they would yield.[23] About the same time American iron masters became interested in alloys, which were later to play so important a part in the development of the steel industry. In 1868 four of the largest rail mills in the United States were experimenting with chrome ore and manganese in the puddling furnace for hardening rail heads, and the Government had ordered an experimental lot of projectiles to be made of chrome iron in order to test their ability to penetrate hardened armor. Mines producing chromite of iron were opened in Maryland and Pennsylvania.[24]

PUDDLING FURNACES AND ROLLING MILLS

Puddling was still the approved process for converting pig iron into blooms and bars, and typical iron works consisted of puddling furnaces and rolling mills. Inventors directed their efforts to cheapening this operation, not only before the introduction of the Bessemer process but also during the subsequent years when the two were rivals. In 1869 the Ellershausen process was employed for a time at Pittsburgh. It consisted of running molten iron from the blast furnace on to a rotating turntable, which received continually at another point crushed ore of selected grades, so that there was built up a cake of iron and ore in alternate layers. The resulting "pig Bloom," 30 per cent ore and 70 per cent pig iron, was broken up, re-heated in a "boiling furnace," and the resulting iron employed in the

[21] *Scientific American*, xv, 97, Aug. 11, 1866; American Iron and Steel Association, *Bulletin*, III, 185, Feb. 17, 1869.

[22] American Iron and Steel Association, *Bulletin*, xxx, 249, Nov. 10, 1896.

[23] American Iron and Steel Association, *Bulletin*, xxx, 3, Jan. 1, 1896; *cf. id.*, I, 326, June 12, 1867; IV, 10-11, Sept. 15, 1869.

[24] *Scientific American*, XIX, 215, Sept. 30, 1868; XIX, 261 Oct. 21 1868; *Van Nostrand's Eclectic Engineering Magazine*, I, 373, Apr. 1869.

manufacture of horse shoes, sheet iron and nails.[25] The best-known improvement of the period, however, was the Dank's puddling machine, which came into commercial use about 1870, though a small experimental furnace was built as early as 1868. It was a rotary machine dispensing with much of the manual manipulation formerly required, and reduced the labor cost of puddling to $4 a ton. This furnace consisted of a horizontal revolving cylinder in which the iron was treated much as in an ordinary furnace, but with a great saving of hand labor.[26] Puddlers were among the highest paid and most intractable workers in the iron trade, and their frequent strikes caused constant interruptions in the business. That was the principal motive for devising a mechanical method to perform the service they rendered; but the need of handling iron in larger masses than previously also influenced this development.

American rolling-mill practice had come to differ from that of England through the invention of the three-high mill by John Fritz, at the Cambria Works, in 1857.[27] Within a few years these mills were common throughout the country. They saved time and labor, particularly in the manufacture of railway iron, by enabling the rails to be passed through the rolls in both directions, instead of passing in only one direction as in the two-high mills still used in England. Only the lower roll was fixed, and consequently the sections of American rails were not as uniform as those of rails made in Great Britain by two-high mills. On the other hand, conventional rail sections were more nearly standardized in the United States.[28] The first American Bessemer rails produced commercially were rolled in 1867 by the Cambria Works, from steel made by the Pennsylvania Steel Company, in a mill ordinarily used for iron rails. As steel rail manufacturing developed, special mills of a heavier type were designed to deal with the new metal.[29]

Shortly before the Civil War cold rolling was invented by an Alsatian metallurgical engineer employed at Pittsburgh; and cold-rolled shafting made at the Jones and Laughlin Works was employed extensively by American machine makers. These works used belts to drive their rolling mills, at variance with the usual American practice of employing gears.[30] About this time the universal mill, having vertical rollers that evened the edges of plated in the process of manufacture, was developed in this country from German antecedents. This innovation was the ancestor of the present

[25] American Iron and Steel Association, *Bulletin*, III, 257, Apr. 21, 1869; for mention of several other processes that received some attention about this time see *Van Nostrand's Eclectic Engineering Magazine*, I, 277, Mar. 1869; VIII, 91–92, Jan. 1873; X, 281, Mar. 1874; XII, 377, Apr. 1875.

[26] American Iron and Steel Association, *Bulletin*, II, 68, Nov. 6, 1867; IV, 386, Aug. 10, 1870; V, 2, Sept. 7, 1870; V, 374, July 26, 1871; VII, 26, Sept. 25, 1872.

[27] American Iron and Steel Association, *Bulletin*, XXV, 353, Dec. 2, 1891; American Institute of Mining Engineers, *Transactions* (Oct. 1872), I, 289–290; *Cassier's Magazine*, VII, 468–472, Apr. 1895; XVII, 459–471, Apr. 1900.

[28] American Iron and Steel Association, *Bulletin*, VI, 392, Aug. 14, 1872.

[29] American Institute of Mining Engineers, *Transactions*, V, 209–211.

[30] *Scientific American*, XX, 50, Jan. 23, 1869; *Atlantic Monthly*, XXI, 31, Jan. 1868; American ron and Steel Association, *Bulletin*, XX, 18, Jan. 20 and 27, 1886.

slabbing mill.[31] Among other original devices introduced during this period was the friction roller, employed to keep free from scale the large "bull head rolls" used in making rail plates.[32] Iron was rolled in larger dimensions than hitherto. Nevertheless, though American mills may have made heavier beams and structural shapes than European mills, in general foreign works excelled our own in their capacity to handle metal in large masses.[33] Tubular rolls for rolling iron, which were invented in England about 1869, appear to have originated independently in this country several years earlier.[34] Rolled steel sheets for locomotive boilers and flues were coming into general use.[35] A plant in Brooklyn was reported to be manufacturing Russia iron successfully, by drawing the rolled sheets in packs under a steam hammer.[36]

FORGING

As late as 1868 the substitution of the direct-blow hammer for the old-fashioned trip hammer was still so recent an innovation that its superiority was questioned; and a year from that date a 23-ton trip hammer was installed at a railway machine shop in Augusta, Maine.[37] Notwithstanding this clinging to old usages, drop forging was rapidly superseding less economical ways of shaping metal, especially in making interchangeable parts of machinery and firearms.[38] To be sure some mechanics still argued in favor of die-forging by hand in case of smaller parts, although they recognized that the latter process could not compete in economy with the former. The manufacture of dies and swedges had brought into being a race of "super-machinists," who worked metal with greater accuracy and skill than had ever before been known in America.

MACHINE TOOLS AND MACHINE SHOP PRACTICE

Engineers and metallurgists saw at once that the success of the Bessemer process would result in the substitution of steel for a wide range of articles which had hitherto been made of iron, and yet the movement was not all one way. The introduction of cold rolling, for instance, caused iron to replace steel in the finger bars of reapers, as they were found more reliable than those made of the latter metal. Iron was rolled cold in commercial shapes to an accuracy within one-thousandth of an inch.[39]

But such reversions to iron were the exception. Cast steel was used to an increasing extent for spur wheels, pinions, bevel wheels, railway frogs, cams

[31] Bridge, *Inside History of the Carnegie Steel Company*, 32–33.
[32] American Iron and Steel Association, *Bulletin*, III, 266, Apr. 28, 1869.
[33] United States Commissioners to the Paris Exposition, 1867, *Reports*, II, 4–5.
[34] American Iron and Steel Association, *Bulletin*, III, 395, Aug. 18, 1869.
[35] American Iron and Steel Association, *Bulletin*, III, 323, June 16, 1869.
[36] *Scientific American*, XX, 218, Apr. 3, 1869; *cf. Van Nostrand's Eclectic Engineering Magazine*, VI, 215–216, Feb. 1872.
[37] *Scientific American*, XIX, 161, Sept. 9, 1868; XXI, 139, Aug. 28, 1869.
[38] *Scientific American*, XV, 271, Oct. 20, 1866; XVIII, 297, May 9, 1868; Roe, *English and American Tool Builders*, 175.
[39] *Scientific American*, XX, 50, Jan. 23, 1869.

and railway axles. In 1869 cast-steel car wheels, made at Pittsburgh by a process in which the fluid metal was pressed in the mold, were submitted to tests which indicated that they were much stronger than those made of cast iron.[40]

By the middle of the century the mechanical equipment of American engineering works had assumed in broad outline the features which exist today, the progress since that time being rather in the betterment of details than in the creation of radically new types of machines. Forges, lathes, milling machines, drills, and shears and planers had come into general use.[41] In 1868 a machine was installed at the Charlestown Navy Yard which would plane a piece of iron 40 feet long, 20 feet wide, and 20 feet high.[42] At the Paris Exposition of 1867 the exhibits of American machine builders received favorable comment. Our machine designers were credited with showing more originality than their British and Continental rivals, although English types continued to be the standard.[43]

Interesting light is thrown on older American shop practice by a criticism written in 1867 by the editor of the British journal *Engineering*, who was himself an American by birth and education. He said that he had known large locomotive works in the United States, "turning out 100 engines a year," which did not possess a transverse section of any engine that they built. The position of the journals upon the axles and other matters of a like nature were shown by cross marks on one-inch square wooden pickets, of which a small bundle was laid away in the pattern shop or in the foreman's room. Mechanical drawing, according to this observer, was not extensively practiced in America. In reply to this criticism men familiar with current shop practice in the United States questioned the general prevalence of such conditions, although admitting that they might still exist in particular plants. Drawings and blue prints were to be found in every foreman's room, and were believed in progressive shops to be quite as necessary as the tools themselves. It was admitted, however, that too little attention was paid to drawings, and "inexcusable errors" of draftsmen all too frequently had to be corrected in the pattern shop, or escaped notice until a casting or forging was completed. An attempt had been made in some shops to furnish to the forgers, the molders and the finishers perfect patterns of every part upon which they worked, so that the mechanic need only follow implicitly the lines and dimensions of the pattern in a purely mechanical way. But it was found more profitable to use drawings instead of patterns, and the practice had been abandoned.[44]

Iron—even pig iron—had become so standardized that in making a steam engine, for instance, which in the early half of the century might have been

[40] *Scientific American*, XVIII, 42, Jan. 18, 1868; American Iron and Steel Association, *Bulletin*, III, 385 Aug. 11, 1869.
[41] Roe, *English and American Tool Builders*, 4.
[42] *Scientific American*, XIX, 214, Sept. 30, 1868; *cf. id.*, XVIII, 294, May 9, 1868.
[43] *Scientific American*, XVI, 390, June 22, 1867.
[44] *Scientific American*, XVII, 377, Dec. 14, 1867.

built from the product of a single blast furnace, one brand would be selected for the bed plate, another for the frame, a third for the cylinders and steam chests, and a fourth for conversion into wrought metal for the pistons and connecting rods.[45] During this phase of progress of the engineering trades, relatively fewer castings and more forgings were used in the manufacture of machinery and metal wares. Naturally the great increase in the use of steel after the introduction of the Bessemer process accelerated this change.

In steel making American practice began to diverge from that of Great Britain at the time the Bessemer process was introduced in this country. The first converters erected in the United States were of local design and manufacture. One early establishment, at Lewistown, Pennsylvania, imported most of its machinery from Leeds, but it failed less than a year after going into operation.[46] Despite the fact that England was the pioneer in this industry, American steel-makers for a period following 1870 excelled their British teachers, at least in turning out a larger product from plants of the same nominal capacity. Later, English improvements again put that nation in the lead.[47] The indirect process was employed in this country from the first. Cupolas with duplicate bottom sections were used for melting. An accumulating ladle resting on scales was placed immediately in front of the cupola. The first experimental converters were of about two-ton capacity, but the early commercial plants almost without exception had five-ton-converters. By 1873 the Cambria Works were making a heat for every 40 or 45 minutes of working day, and producing 956 tons of ingots in a six-days run.[48]

FOREIGN OPINION OF AMERICAN PROGRESS

In 1870 a German metallurgist who visited the principal iron-producing districts of the United States was surprised to find extensive and growing works most unfavorably situated with regard to coal and ore, while localities with greater advantages seemed overlooked. This was partly the result of historical conditions which a visitor, studying the industry solely from the standpoint of economic production at the time, might not understand. Rapidly shifting markets, transportation routes and population, changes in technical processes and fuel, and successive discoveries of new bodies of iron and coal, gave the industry in the United States a geographical instability unknown in older lands. The longer established works on the Atlantic seaboard were relatively less favorably situated in 1870 than they had been thirty years before.

[45] American Iron and Steel Association, *Bulletin*, v, 117–118, Dec. 14, 1870.
[46] American Iron and Steel Association, *Bulletin*, xvi, 325, Dec. 6, 1882; xviii, 291, Nov. 12, 1884; xviii, 298, Nov. 19, 1884; *Scientific American*, xvii, 264, Oct. 26, 1867.
[47] Chapman, *Foreign Competition*, 85.
[48] American Iron and Steel Association, *Bulletin*, viii, 37, Jan. 29, 1874.

This German visitor expressed enthusiastic admiration for the natural advantages which America possessed, compared with those of Europe, and he considered that these enabled the iron workers in the United States to dispense with economies and to neglect precautions that would be necessary to insure success in his own country. He was particularly severe in his strictures on the backward methods of manufacturing coke, and his comments remind us that as late as 1870 most of the coke produced in America was made in heaps without even the use of ovens. Beehive ovens, however, were being built in considerable numbers. The author's comment upon this subsidiary branch of the industry is illuminating:

"When we consider how zealously Americans strive to lessen and lighten handwork, the appearance of an American coking-oven plant can not fail to create a peculiar impression. We find here several rows, consisting of only six to eight ovens each, with bad draught, no signs of a pressing machine to expel the coke, even in cases where the section of the oven would readily admit of it, no opening for filling, in short, the most primitive arrangement, combined with the laborious operation, and yet one so easily obviated, of removing the coke with hooks. As before remarked, at the time of my visit to America, in the spring of '70, there was not in the whole country a rational coking plant."[49]

ORGANIZATION

No significant change occurred in the organization of the iron and steel industry during the Civil War and the subsequent decade. Companies and corporations sometimes operated groups of iron furnaces and rolling mills in conjunction, as they had done for the past twenty years. Historic names and firms began to appear in the records of the industry at this time. In 1864, Mr. Carnegie entered the iron business by acquiring an interest in a rolling mill designed mainly to supply structural iron to railways. This was followed eight years later by the erection of the Lucy Furnace to provide an independent source of pig iron. Mr. Carnegie first became interested in the manufacture of steel in 1873-1875, at the time the Edgar Thomson Steel Company began operations near Pittsburgh.[50] We have already mentioned the organization of the Bethlehem Iron Company, destined ultimately to become one of our largest steel producers, during the Civil War; and how Captain E. B. Ward, a far-sighted Michigan ironmaster, pioneered the Bessemer process in the West, and established a modern iron and steel industry at the head of Lake Michigan.

With the decline of the American merchant marine and the drift of our iron and steel industries westward, eastern engineering works, although they continued to multiply and to enlarge their capacity, came to occupy a relatively less important place in the industrial life of the country. Three of the oldest and best-known iron works at New York City, the Morgan,

[49] Dr. Gustav Klüpfel, quoted in American Iron and Steel Association, *Bulletin*, v, 341–342, June 28, 1871.

[50] American Iron and Steel Association, *Bulletin*, xxxv, 107, July 25, 1901; Bridge, *Inside History of the Carnegie Steel Company*, 17, 21, 78–82.

Etna, and Neptune Companies, consolidated in 1868; at which time their combined pay-rolls carried only 800 names, or about half their maximum working force.[51]

Long before the Civil War, and indeed back in colonial days, American iron-makers had come together from time to time, and had perhaps effected a loose and temporary form of organization, for the purpose of regulating prices and otherwise protecting the interests of their trade. In 1843 there is a record of such a body in Virginia.[52] Again, in 1850 a temporary association of iron manufacturers was formed, mainly for the purpose of securing increased protection against foreign competitors. Five years later the American Iron Association was founded and continued to be an active body until 1859.[53] But a permanent society did not come into existence until the autumn of 1864, when a number of prominent iron manufacturers representing nine states met at Philadelphia and called a meeting of all the manufacturers in the country to assemble in the same city the following November. On the sixteenth of that month the American Iron and Steel Association was organized. This body has continued in existence with changes in name and constitution up to the present time. Its functions have been of a broader and more permanent character than those of the special and subordinate societies founded at various periods to represent the interests of particular branches of the industry and to fix price and labor policies.[54]

FLUCTUATING PROSPERITY

After the activity of the Civil War the iron trade suffered a temporary relapse. In the autumn of 1865 the American Iron and Steel Association reported that anthracite furnaces were operating at less than one-third their capacity and that the important rolling mills of eastern Pennsylvania had either shut down or were running on greatly reduced schedules. More than one-third of the iron establishments and steel works in Pittsburgh were idle. Similar conditions prevailed farther west.[55]

This depression was short-lived, however, and the ensuing five years were a period of well-maintained prices and profitable activity. In the spring of 1870 a sudden fall in gold produced uncertainty as to the future course of prices and alarmed manufacturers, especially in branches of the trade likely to be affected most by foreign competition, and a majority of the rolling mills and steel works at Pittsburgh were running on short time.[56]

This temporary check was followed by two years of abnormal activity, rapidly rising prices and great expansion. With the conclusion of the war

[51] *Scientific American*, XIX, 327, Nov. 18, 1868; Brassey, *Lectures on the Labour Question*, 57.

[52] American Iron and Steel Association, *Bulletin*, XXIX, 59, Mar. 10, 1895.

[53] American Iron and Steel Association, *Bulletin*, VII, 148, Jan. 8, 1873.

[54] American Iron and Steel Association, *Bulletin*, XXII, 340, Nov. 21, 1888; *cf.* also, *Van Nostrand's Eclectic Engineering Magazine*, VII, 440–441, Oct. 1871; VIII, 476, May 1873.

[55] *Scientific American*, XII, 372, June 10, 1865; XIII, 190, Sept. 16, 1865; *cf.* however, *id.*, XIII, 177, Sept. 16, 1865.

[56] American Iron and Steel Association, *Bulletin*, IV, 220, Mar. 16, 1870.

between France and Germany the European demand for iron suddenly increased. The substitution of iron for wood in ships, and the larger employment of iron and steel where other materials had been used previously, rapidly extended the market both abroad and in America. This was also a period of great railway building in the United States, more than 7,000 miles being completed during 1871 alone. It therefore became impossible for this country to supply even approximately its own consumption.[57]

It was symptomatic of this activity that forty new blast furnaces were erected in the United States during 1872, notwithstanding the high cost of construction and of raw materials. As invariably happens after such periods of feverish activity, the situation reversed itself suddenly in 1873. The panic which occurred that year developed into a world-wide depression, although it was felt more acutely in the United States than in Europe. Declines in the prices of iron and steel were almost as great in England, France and Belgium as in our own country. During the period of excessive demand and short supply, speculation was encouraged, and this aggravated a situation already unsound for other reasons.[58]

COSTS AND PRICES

Production costs rose steadily but not uniformly after the outbreak of the Civil War. According to an estimate compiled by the secretary of the Eastern Iron-Masters' Association, it cost in 1860 slightly over $18 to produce a ton of pig iron at an eastern furnace, a figure which declined somewhat during the early part of the war. By 1865, however, it had well-nigh doubled, rising to about $34, and it continued in the vicinity of $30 until 1870, increasing to over $34 in 1873. The cost of producing bar iron varied more irregularly and reached a maximum in 1865, having risen from $52 at the outbreak of the war to $130 the latter year.[59] In 1869 the Commissioner of Internal Revenue investigated the cost of producing iron at several points in the United States, and came to the conclusion that it ranged from $24 to $26 currency per ton in eastern Pennsylvania and slightly less than that west of the Alleghenies. In the Shenango Valley, where Lake Superior ore was used, the cost of production at the furnace was estimated to be about $28.50 a ton. Estimates from the Mahoning Valley were as low as $25. With rich ores the Pittsburgh furnaces could make iron for less than $28 a ton. At Carondolet, Missouri, which was then expected to develop into a great iron-making center, a preliminary account of furnace expenses indicated that iron could be produced for $25.[60] This was cor-

[57] *Van Nostrand's Eclectic Engineering Magazine*, III, 128, Aug. 1870; VII, 659–660, Dec. 1872.

[58] American Iron and Steel Association, *Bulletin*, III, 497, Nov. 19, 1873; IX, 41, Feb. 19, 1875.

[59] American Iron and Steel Association, *Bulletin*, X, 131, May 3, 1876; *cf. Scientific American*, XVIII, 182, Mar. 21, 1868; *De Bow's Review*, Post Bellum Series, VI–VII, 648, July, 1869; Bridge, *Inside History of the Carnegie Steel Company*, 9.

[60] Special Commissioner of the Revenue, *Report for 1869*, LXXXI; American Iron and Steel Association, *Bulletin*, IV, 137, Jan. 5, 1870.

rected as a result of later experience to make the estimate about $32 a ton.[61] In other words, on the eve of the rise of prices which was to culminate in the panic of 1873, it probably cost between $27 and $33 to make iron in the principal producing districts of the United States, or double what it had cost in 1850.[62]

When the Civil War closed, American and foreign iron were selling in the neighborhood of $45 a ton at eastern ports. In 1866, Pittsburgh prices ranged from $42 a ton for common forge iron to $45 and $50 for the best charcoal pigs. At this time coast prices were not infrequently lower than those at interior points on account of the competition of iron from abroad.[63] Although there were temporary fluctuations, these prices were maintained with fair uniformity until 1868, when there was evidence of a consistent decline throughout the country, probably in sympathy with the lowering premium on gold. But the fall did not exceed $3 or $4 a ton.[64] Sales at $30 a ton and even lower were made in 1870, and Philadelphia quotations for northern pig iron fell steadily from $42 a ton to $30 a ton during that and the previous year.[65] This decline affected all forms of raw and manufactured iron, although secondary manufacturing was fairly active. By the spring of 1872 there had been a complete reversal of this condition and the state of the iron market was reported as "in many respects without precedent in the history of the trade." Although every furnace was in blast and importations were as large as the surplus of foreign production permitted, this country was threatened with an iron famine. During the first four months of the year pig iron advanced from $36 to $50 a ton and there was a corresponding enhancement in the price of rails and other finished products.[66]

Conservative furnace men and merchants regarded $50 or thereabouts for pig iron as the maximum price at which sound business could be carried on, but when consumption overtook production, and stocks in hand were rapidly decreasing, speculators became active and large consumers rushed into the market, buying up supplies at unreasonable rates. Immediately the price of ore, coke and labor rose to correspond.

IMPORTS AND EXPORTS

Between the conclusion of the war and the panic of 1873 American industries borrowed extensively from Great Britain and Europe and foreign capitalist made considerable direct investments in enterprises in the United States. This resulted in a heavy movement of merchandise from across

[61] American Iron and Steel Association, *Bulletin*, IV, 169, Feb. 2, 1870.
[62] American Iron and Steel Association, *Bulletin*, V, 343, June 28, 1871.
[63] *Boston Commercial Bulletin; Iron Age;* American Iron and Steel Association, *Bulletin*, for contemporary dates, *passim*.
[64] American Iron and Steel Association, *Bulletins*, II, 325, June 17, 1868; II, 377, Aug. 5, 1868; III, 180, Feb. 10, 1869.
[65] American Iron and Steel Association, *Bulletin*, IV, 212, Mar. 9, 1870; V, 67, Nov. 2, 1870; V, 134–135, Dec. 28, 1870.
[66] *Commercial and Financial Chronicle*, XIV, 450, Apr. 6, 1872.

the Atlantic to our country, no small part of which consisted of iron and steel and their manufactures, especially steel rails. Between 1868 and 1869 the value of our iron and steel imports rose from $12,000,000 to $18,000,000. In 1872 they reached $61,700,000, which was to remain the maximum for several years to come.[67]

Although our imports of iron and steel were so heavy, we exported the same commodities to some extent, the total value shipped abroad being in the neighborhood of $15,000,000. We even sent occasional consignments of pig iron to England, and we sold railway iron to our Canadian neighbors in competition with the British manufacturers who were supplying our own roads. But the main items in our iron and steel exports were finished products, not a few of which we shipped to Great Britain and the Continent.[68] After the War was over, our private arms factories found a market for their goods in Europe. In 1867 the Fort Pitt Foundry was casting heavy ordnance for the government of Chile.[69] The following year the Remingtons supplied a large quantity of rifles to the Swedish and to the Danish governments. The Colt Company had a similar contract with the Russian government. In 1873 the Providence Tool Company was busy making rifles for Turkey. During the panic of 1873, Pratt and Whitney had orders sufficient to employ their shops for two years ahead, most of which were from foreign governments for armory machinery; and simultaneously American exports of hardware likewise increased.[70]

LABOR CONDITIONS

In describing the state of the American iron industry in 1873, Sir Thomas Brassey remarked that the progress made was the more creditable because of the great difficulties experienced in securing a sufficient supply of labor. It was customary to bring skilled puddlers, rolling mill operatives and other mechanics from England under five-year contracts; but as soon as they had served their period, many preferred to take up a farm in the Far West to continuing in their previous occupation. They thus exemplified the drift from wage-earning occupations to independent agriculture which had been going on in America since early colonial days.[71] As long as the manufacture of wrought iron continued to be the key process of the industry, puddlers held a strategic position in the labor force, which they were prompt to use to protect their rights and to better their condition. It was relatively easier to procure founders and furnace men, molders and skilled hands in other branches of the metallurgical industry, than it was to obtain experi-

[67] American Iron and Steel Association, *Bulletins*, IV, 114, Dec. 15, 1869; X, 132, May 3, 1876.

[68] American Iron and Steel Association, *Bulletins*, VII, 321–322, June 11, 1873; VII, 433, Sept. 17, 1873.

[69] *Scientific American*, XVI, 378, June 15, 1867.

[70] *Scientific American*, XIX, 235, Oct. 7, 1868; XX, 74, Jan. 30, 1869; American Iron and Steel Association, *Bulletin*, VII, 330, June 18, 1873; VII, 493, Nov. 12, 1873; Roe, *English and American Tool Builders*, 179.

[71] Brassey, *Work and Wages*, 56, 205; *id.*, *Lectures on the Labour Question*, 50.

enced "boilers" and puddlers. Moreover, the latter were mostly British workmen, who brought with them to America the trade-union traditions of their native country. Within five years of the introduction of puddling at Pittsburgh in 1837, a successful strike was inaugurated by the boilers to prevent a reduction of wages; and similar labor interruptions continued at frequent intervals thereafter. None the less the price of "boiling," which was on a piece-work basis, steadily declined from $7 a ton in the early thirties to $4 or less at the outbreak of the Civil War. During that conflict, while prices and wages were advancing, the rate reached $9 a ton, but it suffered a slight reduction as soon as peace was declared.

The period of readjustment that followed the close of hostilities witnessed the adoption of the first sliding scale for boilers applied in this country. It went into effect at Pittsburgh in 1865, by agreement between the representatives of the employers and employes.[72] Late in 1866 there was a general lock-out to enforce a reduction of wages, followed by the adoption of a new scale. This inaugurated a stormy period in the industry. During the following two years strikes occurred in the Pittsburgh district, at Troy, and among the Welsh puddlers employed at the Tredegar Works at Richmond. Again in 1869, labor troubles in the anthracite coal fields shut down many iron furnaces in eastern Pennsylvania.[73]

Upon the whole, however, wage disputes did not check seriously the growth and prosperity of iron manufacturing. Although labor in America received half again or double the wages paid in Great Britain for the same service, our iron-masters were so fully protected by the tariff, by lower freights, and by the premium on gold, that they easily withstood the competition of their overseas rivals.[74]

STATISTICS OF GROWTH

In 1868 the Special Commissioner of the Revenue reported that notwithstanding continuous complaint as to the depressed condition of the iron interests in the United States, the average annual increase of pig iron produced was remarkably uniform and was greatly in excess of the ratio of population growth. Since 1850 the country's pig-iron output had increased more than 8 per cent per annum, while the yearly addition to the population was only 3.5 per cent.[75] Between 1860, when the United States produced 821,000 tons of pig iron, and 1873, the output more than trebled. The country made in excess of a million tons for the first time in 1864; it did not double this quantity until 1872, when the output suddenly rose to 2,855,000 tons. When the war broke out more than half the iron made in the country was produced with anthracite coal and the annual output

[72] American Iron and Steel Association, *Bulletin*, XVI, 226, Aug. 23, 1882.
[73] *Scientific American*, XVII, 166, Sept. 14, 1867; XIX, 19, July 8, 1868; XIX, 339, Nov. 25, 1868; American Iron and Steel Association, *Bulletin*, I, 325, June 12, 1867; II, 379, Aug. 5, 1868; III, 324, June 16, 1869.
[74] American Iron and Steel Association, *Bulletin*, IV, 361, July 20, 1870.
[75] Special Commissioner of the Revenue, *Report for 1868*, p. 3.

of charcoal iron was more than twice the product of furnaces using bituminous coal and coke. It was not until 1869 that charcoal iron took third place in these three classes, and as recently as 1873 our furnaces made 335,000 tons more anthracite iron than bituminous and coke iron.[76]

Between 1856 and 1862 an absolute decline occurred in the charcoal industry; and less than one-fourth of the iron made in the country during the latter year was produced with that fuel. After the war market made its effect felt, however, the amount of charcoal iron made—omitting the product of the southern states—increased more rapidly than the total output, and at the end of this period it had risen to 28 per cent of our entire production. Although this ratio declined thereafter, the absolute quantity of charcoal iron continued to increase until 1873, when it reached 577,000 tons.[77]

Our production of wrought iron, made either by the old method directly from the ore in bloomeries or from pig in refining forges, reached 75,000 tons in 1868, after which a decline began that was interrupted by a temporary rise to a still higher figure in the early eighties. The amount of rolled iron made in the country increased rapidly with the active railway development of the late sixties and early seventies, rising from 856,000 tons in 1865 to 1,848,000 tons in 1872. Statistics of Bessemer and open-hearth steel begin in 1867, when the country's total production was 3,400 tons. By 1873 the output exceeded 174,000 tons, and though during the depression following the panic the production of pig iron fell off, that of Bessemer steel continued to increase without interruption.[78] In 1867 Abram Hewitt estimated the annual consumption of iron in the United States as about 100 pounds per capita. In 1872 this figure was thought to have risen to 223 pounds.[79]

About half the iron used in the country in the early seventies was employed in railway maintenance and construction, and all of this was rolled. The extension of railways to the remoter sections of the South and West caused the erection of rolling mills at points near these markets. During the decade ending with 1870 they were established at Milwaukee, Indianapolis, St. Louis and San Francisco; and those at Chicago increased their capacity and added blast furnaces to their plants. In fact all these mills, except those at San Francisco, either produced the iron they used, or obtained it from local furnaces with which they were more or less closely associated. In the South the Tredegar Works at Richmond continued to make rails and bridges. Chattanooga became an iron manufacturing city; and the re-rolling of rails, at least, was revived at Atlanta, where this industry had been established before the war. Although the largest rolling

[76] Swank, *Iron in All Ages*, 376.

[77] American Iron and Steel Association, *Bulletin*, XIII, 266, Oct. 22, 1879.

[78] American Iron and Steel Association, *Bulletin*, XIII, 266, Oct. 22, 1879; *id.*, *Statistical Abstract, 1888*, p. 3, 8.

[79] American Iron and Steel Association, *Bulletin*, IX, 251, Aug. 20, 1875.

mills were still east of Pittsburgh or in the immediate vicinity of that city, a tendency of these industries to move westward was observable.

The same westward trend manifested itself in the manufacture of steam engines. Indeed, according to one contemporary observer, the figures of production in 1870 showed—

> "that the East does not even supply its own demand, while the West is making its own engines and boilers, and shipping a small surplus to the older states. This assertion is borne out by details of the operations of western manufacturers in that line. The fact merely illustrates an axiom in this industry, namely, that the cheapest point for the manufacture of iron is the nearest point to the ore beds and coal fields."

At this time engineering works in Chicago were making dredging machines to be used in Pennsylvania and elevator machinery to be installed at Baltimore, and were shipping their products to Cuba and Canada.[80]

The growth of engineering establishments in the West was accompanied by increasing geographical specialization in the metal working industries.[81] In 1872 Philadelphia had 549 establishments engaged in the manufacture of iron and steel and their products, producing over $40,000,000 worth of finished goods per annum. Cincinnati's annual production at this date was valued at $22,000,000.[82]

[80] American Iron and Steel Association, *Bulletin*, VII, 410, Aug. 27, 1873.
[81] *E. g.* Roe, *English and American Tool Builders*, 219, 229.
[82] American Iron and Steel Association, *Bulletin*, VI, 291, May 15, 1872; VII, 157, Jan. 16, 1873.

CHAPTER IX

ENGINEERING INDUSTRIES

SHIPBUILDING

Our merchant marine declined during the Rebellion principally for four reasons: steamships were superseding sailing vessels and iron was replacing wood for ship construction, both of which changes favored British shipyards; the navy drafted a great number of American cargo carriers and passenger boats into military use, withdrawing them from trading routes at a time when they could not easily be replaced by the original owners; Confederate privateers raided the ocean commerce of the Northern states, destroying many vessels and increasing insurance rates and other costs of transportation under the American flag; heavy taxes, the premium on gold, the scarcity of seamen, and the entire complex of economic conditions created by the war favored the transfer of American-owned ships to foreign buyers.[1] As we have previously noticed, however, war conditions merely accelerated a process which was under way before hostilities began.

The American public was not familiar with the broader economic influences which under normal conditions foretold this decline. A vivid memory of more than a century of active competition with the mother country upon the sea still survived in the minds of the people. Many anticipated confidently that as soon as hostilities ceased America would speedily recover her old position in the foreign carrying trade.

Possibly this expectation, as well as the persistence of old habits, encouraged a revival of shipbuilding after the war for which there was not sufficient economic justification. In 1866 the Maine shipyards were busy, although it was already noted that more steam vessels and fewer sailing vessels were being constructed. According to a contemporary observer—

> "All the coasting trade is being done by screw steamers and a few side wheel vessels ranging from 800 to 1,500 tons, and the few sailing vessels building are small craft of no great burden."[2]

At this time our only important trans-oceanic line was the Pacific Mail, which was placing orders for what were then considered magnificent steamships for the Oriental trade. Their dimensions were about 360 feet by 50 feet beam. Even larger wooden steamers—in this instance side wheelers—

[1] *Scientific American*, XVI, 34, Jan. 19, 1867; American Iron and Steel Association, *Bulletin*, VII, 353, July 9, 1873.

[2] *Scientific American*, XIV, 134, Feb. 24, 1866; XVI, 73, Feb. 2, 1867.

were also under construction in 1866 for the passenger traffic along the North Atlantic coast. In 1867 the Maine shipyards had about 100,000 tons of wooden vessels on the ways, or more than at any time since before the war; but the following year was marked by a sharp reaction, which a conference of shipbuilders at Bath attributed to heavy duties on raw materials. This was an old plea of vessel owners and shipbuilders in New England, who from the first days of the Republic had been vigilant and persistent opponents of a protective tariff. Figures cited at this conference did indeed show that the cost of building vessels in America had risen remarkably. A white-oak ship of 1,200 tons or thereabouts could be built before the war, ready for sea, for about $47 a ton. At the close of the conflict and for some years thereafter, the price did not fall below $75 a ton. During the depression we have just described, the cost fell to $68 per ton.[3] One of the grievances of ship builders and ship owners in New England was that their timber, most of which was imported from Canada, paid an export duty in that country and an import duty in the United States; in addition to which the builder or owner paid an internal revenue tax of 30 cents a ton.

Meanwhile, the construction of iron vessels, which even before the war had begun in a tentative way at the marine engine works on the Hudson and the Delaware, began to assume the proportions of a well-established industry. While our builders of wooden ships, using materials the abundance and cheapness of which had from colonial times given us many advantages over foreign rivals, were protesting against the tariff on timber, the Delaware builders, using iron which at that time was made more abundantly and cheaply in Great Britain than in America, refused to join in an application for lower duties on their materials. Probably they feared that they would thus encourage an agitation in favor of repealing the duty on iron steamers purchased by American owners for employment in the coasting trade and in Government-encouraged trans-oceanic commerce. In 1868 less than 3,000 tons of iron vessels were constructed in the United States. This figure rose to over 15,000 tons in 1871.[4]

About this time the keels for several trans-Atlantic and trans-Pacific steamers were laid down at Delaware River yards. Two 5,000-ton vessels costing over $1,000,000 each were built for the Pacific Mail.[5] Four vessels of over 3,000 tons were simultaneously constructed for trans-Atlantic service and were reported in the press of that day to cost less than if built in England. By 1872 this industry had become an important consumer of American iron. That year Cramp and Sons bought 8,000 tons of plates, beams and rivets from American makers.[6] John Roach, who owned the

[3] *Commercial and Financial Chronicle*, VI, 264, Feb. 29, 1868.

[4] American Iron and Steel Association, *Bulletin*, III, 315, June 9, 1869; VI, 154, Jan. 17, 1872; VII, 195, Feb. 19, 1873; Swank, *Iron in All Ages*, 442–443, 447; Tenth Census, *Reports*, VIII (Shipbuilding), 197.

[5] American Iron and Steel Association, *Bulletin*, VII, 234, Mar. 26, 1873.

[6] American Iron and Steel Association, *Bulletin*, VI, 154, Jan. 17, 1872; VII, 354, July 9, 1873,

old Morgan Iron Works in New York, had just established large yards at Chester, which were destined to play an important part in the history of American ship-building during the next few years.[7] Iron vessels were built at interior ports, in some cases for export. Two iron river boats were launched at Pittsburgh for a Brazilian company and shipped to that country in sections.[8] The first iron steamer ever constructed at Cleveland was launched in 1868. San Francisco works were building iron steamers for Mexico.[9]

LOCOMOTIVES

In 1867 an American locomotive received a gold medal at the Paris Exposition, largely, it is said, through the influence of the British member of the international jury.[10] This long-established industry was enjoying a period of great prosperity, due to the rapid extension of railways in the West, and new works were springing up at many points. In 1867 the first locomotive ever built in Pittsburgh was delivered, and about the same time Booth and Company, of San Francisco, entered this industry. The Schenectady works had become producers, and the Burnside Rifle Works at Providence were reorganized in 1866 as the Rhode Island Locomotive Works. Two years later this establishment, on the eve of an enlargement designed to double its existing output, was making five locomotives a month. Other New England makers were declining orders because their entire capacity was engaged.[11] Though the price of locomotives and other railway equipment declined by the end of the decade,[12] there was no abrupt check to this activity until the panic of 1873, which was temporarily disastrous to the industry. The Baldwin Works, which had long been the largest in the country, made but 160 locomotives in 1874, as compared with 500 the preceding season, and such orders as they received during the following depression were largely from foreign buyers.[13]

In 1866 a locomotive built at East Boston for the Lehigh Valley Railroad, weighing 30 tons and capable of drawing 200 five-ton cars of coal, was regarded as a "monster," pointing to a "revolution in the freighting business of the country." Other locomotives of this type were being built for the Central Pacific Railway.[14] Eight years later what was said to be the largest locomotive in the world was put into service on the Philadelphia

[7] American Iron and Steel Association, *Bulletin*, VII, 355, July 9, 1873; VII, 425–426, Sept. 10, 1873; VII, 484, Nov. 5, 1873.

[8] American Iron and Steel Association, *Bulletin*, VII, 517, Dec. 3, 1873.

[9] *Scientific American*, XVI, 346, June 1, 1867; XIX, 118, Aug. 19, 1868.

[10] *Scientific American*, XVI, 360, June 8, 1867; *cf. id.*, 334, May 25, 1867; U. S. Commissioners to the Paris Exposition, 1867, *Report*, IV (Steam Engineering), 13.

[11] *Scientific American*, XIV, 48–49, Jan. 20, 1866; XVI, 302, May 11, 1867; XVI, 327, Aug. 17, 1867, XIX, 262, Oct. 21, 1868; *Van Nostrand's Eclectic Engineering Magazine*, I, 95, Jan. 1869; I, 666–667, July 1869.

[12] Massachusetts Railroad Commissioners, *Report, 1872*, p. ccxix.

[13] American Iron and Steel Association, *Annual Report*, 1875, p. 6; Trumbull, *Industrial Paterson*, 123.

[14] *Commercial and Financial Chronicle*, II, 728, June 9 1866.

and Reading Railroad. It had 12 four-foot driving wheels and weighed 60 tons without the tender.[15]

MISCELLANEOUS IRON AND STEEL MANUFACTURES

A great increase in the demand for wire followed the introduction of the electric telegraph. The decade of the forties also witnessed the substitution of wire ropes and cables for many uses where hemp had formerly been employed.[16] A growing market stimulated improvements in the method of manufacture, and between 1869 and 1873 the Washburn and Moen Company at Worcester partly introduced from England and partly perfected independently important improvements in the methods of rolling wire rods and manufacturing wire that enabled them greatly to increase their production.[17] This industry was on the eve of remarkable expansion, especially in the West. Between 1865 and 1874, the barbed-wire fence was gradually perfected by several patentees. Simultaneously a Catholic priest at Covington, Kentucky, began operating in a small way a primitive machine for making wire nails which he had imported from his native country, Germany.[18] Both these new uses, as well as the large employment of wire cables in suspension bridges, exercised an important influence upon this branch of metal working during the ensuing decade.

Steel plows, mowing machines and harvesters kept pace with track layers in the invasion of the western prairies. In 1865, 80,000 reapers and mowers were manufactured in the United States, and orders outran the supply.[19] American makers received a grand prize and a gold medal at the Paris Exposition of 1867, where their harvesters and mowing machines easily demonstrated their superiority over those of foreign competitors.[20] Nevertheless there was complaint of careless construction during the initial boom period of the industry. A correspondent writing to the *Scientific American* in 1869 said that he had never seen a reaper that could be set up and run without the aid of a file or cold chisel, and that sometimes new holes had to be made in order to get in the assembly bolts. All manufacturers were not open to this criticism and machines from some factories could be taken apart, the pieces piled up indiscriminately, and reassembled like a Springfield musket.[21]

During and immediately following the Civil War, American makers obtained substantial control of the domestic hardware market, which ten years before had been supplied to a considerable extent from England.

[15] American Iron and Steel Association, *Bulletin*, VIII, 222, July 16, 1874; *cf. id.*, XXXV, 97, July 10, 1901; *Cf. Van Nostrand's Eclectic Engineering Magazine*, IV, 330, Mar. 1871.

[16] American Iron and Steel Association, *Bulletin*, XX, 275, Oct. 20, 1886.

[17] American Iron and Steel Association, *Bulletin*, XXV, 370, Dec. 16, 1891; XXVII, 337, Nov. 22 and 29, 1893; Washburn, *Industrial Worcester*, 152–153.

[18] American Iron and Steel Association, *Bulletin*, XXX, 18, Jan. 20, 1896; XXXV, 10, Jan. 23, 1901.

[19] *Scientific American*, XV, 49, July 21, 1866.

[20] United States Commissioners to the Paris Exposition, 1867, *Reports*, I, 106, 315–316.

[21] *Scientific American*, XX, 54, Jan. 23, 1869; XX, 166, Mar. 13, 1769.

On account of the high cost of labor in this country, and the excellence of our castings, early American makers often employed cast parts where English makers used wrought iron, and their products not only had the reputation of being inferior to those made abroad, but merited the prejudice which existed against them. During the Civil War the machinery and the shop practice of metal-working establishments greatly improved, because they were largely devoted to the manufacture of firearms and munitions for the Government, where work had to comply with exacting specifications. These new standards of quality and accuracy were carried over after the war into other lines of production. In 1873 the London *Times* commented upon the fact that the shops of Birmingham and Sheffield were not only losing their former market in the United States, but were encountering the competition of American hardware in Canada, Australia and New Zealand. "Hardware merchants of New York are all agreed that the day for the sale of English hardware in the United States has almost departed." This was due in no small degree to the fact that the development of labor-saving machinery for working wrought iron and steel had reached a point where the cost of production in the two countries was nearly equalized in spite of the lower wages paid in Great Britain. By the year mentioned, "railway fastenings, door locks, spring bars, curry combs, tin ware and some descriptions of edge tools" were among the articles in which American competition was beginning to be felt by British manufacturers.[22]

At a much earlier date American axes and farm implements had competed successfully with those of foreign makers, both at home and abroad, partly because of their greater lightness and convenient design. After the war our makers held this market, and in 1873 we are told—

> "The stores of Sidney and Melbourne are stocked with American shovels, American buckets, and above all with American axes, and a bushman would as soon think of felling a tree with a flint implement from the drift as with an axe of English pattern."[23]

In 1872 the so-called Barron process for the manufacture of steel tools was in operation at Louisville, Kentucky, where it was reported at the time to be meeting "with very encouraging success." Tools prepared by this process were first made of cast iron, polished by turning in a revolving drum, annealed, and subsequently subjected to the "vapor of gasoline and other carbonaceous materials" in a retort.[24] Rolling was substituted for hammering in making the blades for table cutlery.[25] American tools had

[22] American Iron and Steel Association, *Bulletin*, VII, 330, June 18, 1873; VII, 411, Aug. 27, 1873; Brassey, *Work and Wages*, 134–135.

[23] London *Times*, quoted in American Iron and Steel Association, *Bulletin*, VII, 370, July 23, 1873.

[24] American Iron and Steel Association, *Bulletin*, VII, 105, Dec. 4, 1872.

[25] American Iron and Steel Association, *Bulletin*, VIII, 355, Nov. 26, 1874.

acquired and established reputation abroad as well as at home, though the steel from which the best of them were made still came from England.[26]

MACHINE SHOP PRACTICE

This was a period of increasing precision and standardization in all processes of metal manufacture. William Sellers of Philadelphia was a leader in this direction. When President of the Franklin Institute, in 1864, he read a paper before that body recommending the standard pitch and cross-section elements of screw, bolt and nut threads that were subsequently adopted by the United States and generally throughout Europe. Three years later he perfected an automatic gear cutter that caused the rapid substitution of cut gears for the cast gears previously in use.[27] The improvements in shop practice that marked the third quarter of the century are suggested by the following contemporary quotations:

"If a machinist who had enjoyed a Rip Van Winkle sleep of a quarter of a century should now awake and essay to work in his trade in a well-appointed shop, he would find himself as far behind the requirements of his business as when he first entered the shop as an apprentice. He would find the file, which in his day was the favorite tool and scarcely ever out of his hands, superseded by the planer, sharper, milling machine, turning tool, and many other devices which perform the work more accurately, quicker, and with much less expenditure of labor. The center punch, bench centers and hammer have largely given way to the centering machine; the screw cutting and tapping machine does much of the work formerly performed with the hand screw plate and hand tap, and more perfect bench tools, such as gages, try squares, straight edges and the like, assist him in the manual labor."[28]

Again, to quote from the same source at a later date:

"When we were serving our novitiate at the machinist's business, and long after, it was compulsory that every workman should have his own inside and outside callipers, straight edges, squares, rules, hammers, etc., and to furnish his drills, turning tools, planing chisels, and many other appliances used in his work. He must also contrive temporary chucks for boring and turning, and make his drill holders or chucks. Many of these tools were considered by their makers their masterpieces and were often marvels of skilled and patient labor. In accuracy, facility of handling, and beauty, many of them compare favorably with the machine-made standard articles . . . . . Still, we should not advise the waste of time and expenditure of labor by the workman in the manufacture of his own tools, when for a fraction of the value of that time and labor he can purchase accurate and handy instruments which can be relied on . . . . We have now gages, rules, circular iron-cutting saws, squares, turning tools, etc., which for handiness, excellence of material, and accuracy are unsurpassed. They are made by machinery which is infallible in its operation, and by manufacturers

[26] *The London Manufacturer*, quoted in *Scientific American*, XIX, 2, July 1, 1868; *The Steel Duties, Pamphlet No. 2:* Compiled from Back Numbers of the *Boston Journal of Commerce*, Jan. 4–Feb. 14, 1874.

[27] Roe, *English and American Tool Builders*, 248–249; American Iron and Steel Association, *Bulletin*, XXX, 227, Oct. 10, 1896.

[28] *Scientific American*, XVI, 301, May 11, 1867.

who make them a specialty and base their reputation on their perfection. These tools have been as great an aid to the progress made in machine building as any other one agency. But they have an advantage beyond this. They produce uniformity of work, uniformity of measurements, uniformity of construction throughout the country, rendering repairs more easy and replacement of parts less difficult."[29]

Such technical advances helped to ease over the transition from war production to peace production in the metal-working trades. A competent British observer noted this in the case of the Peabody Rifle Company of Providence, which had been making small arms for the Government. With the conclusion of peace the demand for rifles, notwithstanding considerable orders from abroad, was not sufficient to keep the works busy.

"Therefore," says this writer, "with the fertility of resource which distinguishes American industry, the manual skill of a large body of workmen especially apt in the production of tools or machinery composed of small and interchangeable parts, and the valuable and ingenious plant of the company, are now employed in the production of sewing machines."[30]

MINOR INDUSTRIAL METALS

With the economic conquest of the West, America's output of industrial metals increased, not only absolutely, but also relatively to the nation's rapidly growing demand for them. Between 1860 and 1873 the quantity of copper mined in the country more than doubled, rising to 15,500 tons the latter year, when it about equaled consumption.[31] Most of this increase came from the Lake Superior region, though new sources of supply were discovered in California and elsewhere. Before the Civil War most of the copper used in the United States was imported from Chile and Cuba, in the form of ores and concentrates, which were smelted, refined and rolled at various points on the Atlantic coast, particularly Baltimore.[32] These eastern smelters suffered during the war, and again in 1869 from high duties on imported ore.[33] Meanwhile copper smelting, like iron smelting, became established in the West, and at Pittsburgh and Cleveland—where ore and fuel met.[34] The later development of copper smelting in the vicinity of New York owes its origin to the earlier existence of a chemical industry at these points, which invited the establishment of plants to work up the cinder of the pyrites burned in the acid factories.[35]

Shortly before the Civil War the production of spelter or metallic zinc began experimentally in Pennsylvania, and in 1859 this business was established on a commercial scale by an American promoter employing foreign

[29] *Scientific American*, XVIII, 185, Mar. 21, 1868.
[30] Brassey, *Lectures on the Labour Question*, 50.
[31] *Cf. Commercial and Financial Chronicle*, XIV, 481, Apr. 13, 1872; United States Revenue Commission, *Reports, 1865–1866*, 294–313.
[32] *Hunt's Merchants' Magazine*, LVI, 297–298, Apr. 1867; LIX, 146, Aug. 1868.
[33] *Mineral Industry*, IV, 275; Special Commissioner of the Revenue, *Report for 1869*, p. cix.
[34] *Hunt's Merchants' Magazine*, LIX, 146, Aug. 1868.
[35] *Mineral Industry*, IV, 276.

workmen near Friedensville in that state.[36] Zinc oxides, which were used in paint, had been produced before this, and they continued to be manufactured at various points, notably in Tennessee, where no metallic zinc was made.[37] Pennsylvania works continued to turn out bar and sheet zinc, but this industry developed more rapidly near La Salle, Illinois, and Mineral Point, Wisconsin, where spelter was a by-product derived from the lead ores of the Wisconsin-Missouri district.[38] In 1868 the mines at Potosi, Missouri, yielded daily 1,400 pounds of zinc.[39] American production, however, was not sufficient to supply our manufacturers and a relatively large proportion of what we consumed continued to be imported. In 1872 the domestic output was about 2,500 tons, and our imports were in the neighborhood of 3,600 tons. At this time zinc was chiefly used for manufacturing brass, bath tubs, signs, lamps, organ pipes, nails and in galvanic batteries.[40] One of the largest uses was for galvanizing iron—an industry which had become well established in America during the decade preceding the Civil War.[41]

In 1867 the Galena, Illinois, district still contained the principal lead mines in the country, although the output had greatly diminished since 1845, their year of maximum production.[42] Works were erected at San Francisco in 1867 to smelt lead from California ore and from this time dates an expansion of output that soon made the United States the world's largest producer of this metal.[43] In 1870 the yield of the Galena mines was about 15,000 tons per annum, or only a little more than one-fourth what it had been a quarter century before, and we still imported over 40,000 tons per annum. Our consumption was larger, perhaps, than that of any other country, partly because of the extensive use of lead pipe in city water works and partly because of the great demand for metallic paints to protect our wooden buildings.[44]

Nickel mines were worked in the United States before the Civil War, but the commercial production of this metal began with the establishment of reducing works in Pennsylvania and New Jersey, soon after 1862, in order to supply the mint with nickel for making fractional currency. Joseph Wharton, the founder of this industry, is also credited with having begun the manufacture of metallic zinc in Pennsylvania, three years previously.[45]

Tin has never been produced permanently in this country on a commercial scale. A bar of American tin smelted from Missouri ore was exhibited at

[36] American Iron and Steel Association, *Bulletin*, XLI, 20, Feb. 22, 1907; *Scientific American*, XVII, 182, Sept. 21, 1867; *cf.* I, 414, footnote 58.
[37] American Iron and Steel Association, *Bulletin*, XVIII, 278, May 2, 1868.
[38] American Iron and Steel Association, *Bulletin*, XVI, 73, Feb. 2, 1867.
[39] American Iron and Steel Association, *Bulletin*, XIX, 327, Nov. 18, 1868.
[40] *Commercial and Financial Chronicle*, XIV, 43, Jan. 13, 1872.
[41] American Iron and Steel Association, *Bulletin*, XIX, 29, Jan. 28, 1885.
[42] *Scientific American*, XVII, 150, Sept. 7, 1867.
[43] *Scientific American*, XVII, 326, Nov. 23, 1867.
[44] *Commercial and Financial Chronicle*, XIII, 796–797, Dec. 16, 1871.
[45] American Iron and Steel Association, *Bulletin*, XXII, 201, June 27, 1888; XXXVIII, 156, Oct. 25, 1904.

the St. Louis Fair in 1867, and in 1869 a bar of merchantable tin weighing 85 pounds was reported to have reached San Francisco from a mine in San Diego County,[46] which in the eighties produced this metal for a very brief period in commercial quantities.

Although American tinware had constituted the principal stock in trade of the ubiquitous Connecticut peddler since colonial days, not a box of tin-plates was manufactured in the United States up to 1872. About 1868 the Cambria Iron Company sent an experienced mechanic to Europe to learn how to make them, and other interested parties subsequently sent agents abroad for this same purpose. In 1872 and 1873 works were built at Leech, Michigan, Demmler, Pennsylvania, and Wellsville, Ohio, to manufacture plates. All of them ultimately became producers, but their history properly belongs to a later period.

Brass-rolling was a highly developed and narrowly localized industry in the Naugatuck Valley long before the Civil War. The use of this metal and of copper, which was manufactured into finished goods in the same vicinity, had increased largely after the invention of the electric telegraph and the improvement of machinery for spinning brass utensils and for rolling tubing and other special shapes. With the discovery of petroleum a new use for the same metal was found in lamps and lamp burners. During the war, brass and copper parts were in demand for military equipment and on naval vessels. About the time that war requirements ceased, the manufacture of metallic cartridges afforded a new market for this material.[47]

[46] *Scientific American*, XVII, 310, Nov. 16, 1867; XVII, 326, Nov. 23, 1867; XX, 92, Feb. 6, 1869.
[47] *Scientific American*, XIX, 161, Sept. 9, 1868; *cf. id.*, XVII, 102, Aug. 17, 1867; XVIII, 310, May 16, 1868.

CHAPTER X

COTTON MANUFACTURE

RAW COTTON

An expansion of cotton manufacturing throughout the world followed the peace of 1865 and for several years thereafter spindle capacity kept ahead of the production of raw materials. The South was prevented by the after-effects of the war, and particularly by the change in its labor system, from raising immediately as large a crop as it had before hostilities. Many big plantations were broken up through the renting of land in small parcels to negro tenants. The manufacturer could no longer go into the market and purchase a hundred bales or more of cotton, the uniform growth of one plantation, but had to depend on selection and mixing for making his standards. In 1866 the American crop rose for the first time since the interruption of the war to over 2,000,000 bales, but this was less than half the crop in 1860. The diminution was attributed to financial uncertainty and scarcity of draft animals, seed and labor.[1] Except in 1867 it constantly exceeded that figure thereafter, and in 1871 a record crop of 4,347,000 bales was raised, a quantity not again equaled until 1876.[2]

By 1868, therefore, cotton had nearly regained its former importance as the country's leading commercial crop. The exportable surplus was estimated to be worth $125,000,000 in gold, or almost as much as before the war.[3] Since the premium on gold was directly influenced by the amount of cotton exported, and our imports of other products were also materially affected by the premium on gold, the cotton movement was claimed with some show of reason to control the foreign trade of the country. Prices were well maintained, being fixed in a world market not likely to be influenced by purely local changes.

It was estimated in 1868 that the consumption of northern mills was about 825,000 bales, and of southern mills 60,000 bales. Since 1860 the country's spindles had increased from 5,000,000 to over 6,300,000.[4] The largest consumption was in Massachusetts, where one-third of all the cotton manufactured in the United States was spun. Rhode Island, New Hampshire, Pennsylvania, Connecticut and Maine followed in the order

[1] *Scientific American*, XIV, 394, June 9, 1866.

[2] U. S. Dept. Commerce and Labor, *Statistical Record of the Progress of the United States, 1800–1907*, p. 28.

[3] *Hunt's Merchants' Magazine*, LIX, 371, Nov. 1868.

[4] *Hunt's Merchants' Magazine*, LIX, 302, Oct. 1868.

named, the New England states spinning almost three-quarters of the cotton used in the country. Georgia was the leading cotton mill state of the south. The largest factories were in Maine and New Hampshire, where the average number of spindles was 20,000; and the finest yarn was spun in New Jersey, where the average count was 36.[5]

The rapid increase of railway facilities in the South during the reconstruction speculative era made some changes in the routing of cotton. Relatively less was now shipped via the Ohio and the Great Lakes, the inland crop reaching the sea by rail at Charleston and especially Norfolk.[6] By 1872 the country's consumption reached almost 1,100,000 bales and the estimated amount manufactured south of Mason and Dixon's Line had doubled during the previous four years.[7] It is suggestive of the coarser quality of the fabrics made in the United States as compared with Great Britain and Europe, that nearly all the sea-island cotton raised in the country was exported, only 1523 of the 26,289 bales produced in 1872 being consumed by our own manufacturers.[8] Complaints of the quality and condition of cotton received at northern mills were common during this period.[9]

TECHNICAL DEVELOPMENT

No revolutionary inventions occurred in the field of cotton manufacturing during these years. In 1870 Oliver Pearl of Lawrence, Massachusetts, patented certain improvements in the ring spindle, which had not been greatly changed since its invention by a New England mechanic more than 40 years before. The improvement consisted of a bobbin made of a thin light shell or barrel of wood carried by frictional bearings on the spindle itself. This enabled the spindle to be greatly shortened and lightened, with the result that one-third the power used previously was saved and 1,000 revolutions a minute were added to its speed.[10] Even earlier, about 1866, Francis J. Rabbeth, of Ilion, New York, made improvements in spindles that were eventually combined with further developments, made by Jacob H. Sawyer, of Lowell, along the line suggested by the spindle just mentioned, in a spindle that could be run successfully 10,000 revolutions a minute, or nearly twice as fast as the spindles previously in use, thus practically doubling the capacity of mills.[11]

In 1867 a controversy arose over the relative merits of American and British cotton machinery. Some southern manufacturers and mill super-

[5] *Hunt's Merchants' Magazine*, LIX, 417, Dec. 1868.
[6] *Hunt's Merchants' Magazine*, LXIII, 283–285, Oct. 1870.
[7] *Commercial and Financial Chronicle*, XV, 314–315, Sept. 7, 1872; *cf. id.*, IX, 586, Nov. 6, 1869; *Hunt's Merchants' Magazine*, LIX, 302, Oct. 1869.
[8] *Textile Record*, I, 20, Oct. 1880.
[9] *E. g.* New England Cotton Manufacturers' Association, *Proceedings, seventh annual meeting, April 17, 1872*, p. 36.
[10] Webber, *Manual of Power*, 67–68.
[11] New England Cotton Manufacturers' Association, *Proceedings, Boston, April 29, 1891*, 22–43.

intendents contended that English machinery was more efficient as well as cheaper than that made in the United States. This claim was vigorously disputed, not only by machine manufacturers but by spinners, although it was admitted that during the war and immediately afterward, British machine makers could deliver equipment in America more promptly and at lower prices than could American shops. It is interesting to note that this question turned largely on the question of output rather than of quality of workmanship and durability of construction. It was brought out during the discussion that "men who left the cotton manufacture ten years ago —that is, in 1857—as practical operators, are today nowhere." Apparently mill superintendents felt that although no single revolutionary improvement had been made in textile machinery during the interim, the progress represented by perfection of details and of practice constituted a very great advance.[12]

PRICES AND PROFITS

In 1868 cotton planters and spinners from all parts of the United States met at New York and organized the National Association of Planters and Cotton Manufacturers, which held its first annual meeting in the same city on June 30 of the following year. This society, like similar associations of iron and steel and of wool manufacturers, at once set about gathering both cotton field and cotton mill statistics. The first report indicated that the number of spindles in the country was about 6,750,000 and the average consumption of cotton about 1,000,000 bales. Other early inquiries of the association disclosed the fact that during the previous cotton shortage, mills had taken to spinning finer numbers than formerly and the average size of yarns made in the northern states was $27\frac{3}{4}$ instead of between 21 and 24 as had been estimated.[13] In 1870 the New York Cotton Exchange was organized and began its operations in the autumn of that year with 132 members. It superseded the New York Board of Cotton Brokers, whose members for the most part joined the exchange and soon made it the controlling organization in the American cotton trade.[14]

The rapid growth of cotton manufacturing after the war was in the face of a marked decline in prices. Brown sheetings, which sold for 32 cents a yard in the summer of 1865, could be bought for 18 cents a yard two years later; denims fell from 65 cents to 35 cents. Wages were simultaneously reduced. A cut of 25 per cent in the rate of pay of operatives at Manayunk near Philadelphia in 1867 caused the stoppage of 12 mills during this period of adjustment.[15] Northern manufacturing companies, while not uniformly prosperous, for the most part paid regular dividends. In 1866 the Chockopee Manufacturing Company distributed 45 per cent to its

[12] *Scientific American*, XVI, 73, Feb. 2, 1867; XVI, 121, Feb. 23, 1867.
[13] National Association of Cotton Manufacturers and Planters *Proceedings of First Annual Meeting, June 30, 1869*, p. 7.
[14] *Hunt's Merchants' Magazine*, LXIII, 291, Oct. 1870.
[15] *Scientific American*, XVII, 38, July 20, 1867.

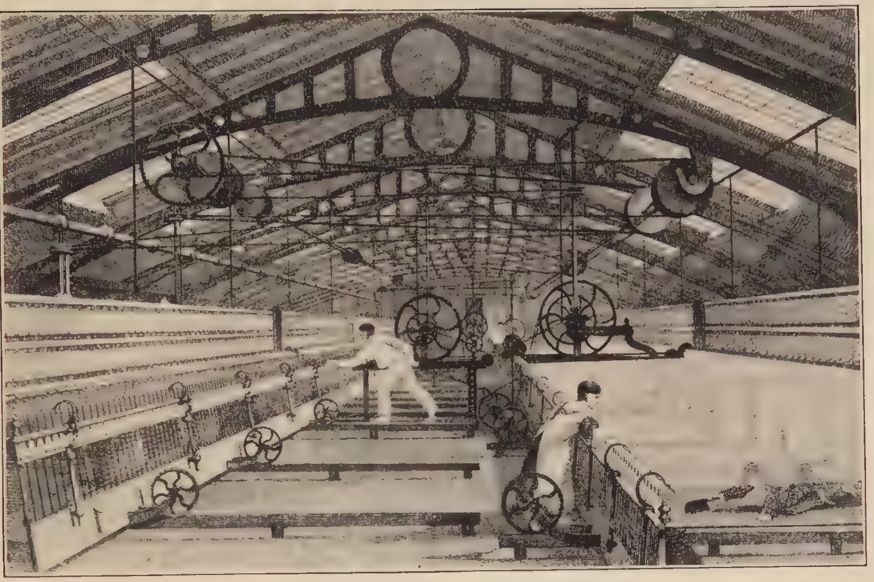

FIG. 1.—Mule Spinning in the Thirties

FIG. 2.—Modern Frame Spinning

shareholders. The following year the Merrimac Company distributed 45 per cent to its shareholders. The following year the Merrimac Company paid 25 per cent; and the Naumkeag Company paid 22 per cent after providing liberally for depreciation and reserves.[16] The average dividends of the Lowell companies for the decade ending with 1870 slightly exceeded 18 per cent.[17]

Southern manufacturers also made liberal profits. In 1871 the Petersburg, Virginia, mills netted 25 per cent.[18] The Saluda Cotton Mills were marketing yarn in Philadelphia at less than 30 cents a pound. These yarns were said to equal yarns selling at 60 cents a pound in London.[19] A report of the Augusta Manufacturing Company of Georgia, in 1868, stated that the present owners had bought their plant on credit ten years before —two years prior to the outbreak of the war—for $140,000, and had at once expended $60,000 in rehabilitating the property, which was in a dilapidated condition, and for commercial capital. During the ensuing ten years, including four years of hostilities, the new proprietors had paid for the entire property without calling on the stockholders for another dollar, had added largely to their equipment of land and buildings, had bought about $100,000 worth of new machinery, had increased the capital to $600,000 from their surplus, had paid dividends regularly, and owned clear of debt at the conclusion of the period an establishment worth $600,000 in gold. During the three years since the war the company had paid out $360,000 in dividends and had added over $124,000 to its surplus.[20]

BOOMS AND DEPRESSIONS

Naturally a cycle when the business world contained as many unstable elements as it did during the readjustment of prices and currency and the reconstruction of the territory of the Confederacy after the war, witnessed minor booms and depressions. When hostilities ceased, northern merchants rushed goods into the country from Europe and bought what they could obtain from domestic producers, paying almost any price asked in their eagerness to get into the destitute southern market before it was supplied from other sources. They regarded cotton as the quick asset of that section, although past receipts were small. This was natural. But railroads were torn up or lacked rolling stock, planters were poorly supplied with draft animals, and the people, being doubtful of the general policy of the Federal Government, did not hasten with the eagerness predicted to dispose of any cotton they might possess. The result was a shock to the cotton buying world; for curiously enough, at the very beginning of a peace

[16] *Scientific American*, XV, 64, July 28, 1866; XVI, 167, Mar. 16, 1867; XVII, 22, July 13, 1867.
[17] Computed from table in *American Wool and Cotton Reporter*, XV, 1042, Aug. 1, 1901.
[18] *Commercial and Financial Chronicle*, XIII, 590, Nov. 4, 1871.
[19] *De Bow's Review*, Post Bellum Series, VIII, 469–470, May–June, 1870; *Hunt's Merchants' Magazine*, LXII, 92, July 1869.
[20] *Scientific American*, XX, 2, Jan. 1, 1869; *De Bow's Review*, Post Bellum Series, 470–471, May–June, 1870.

which was supposed to open a new source of cotton supply, a cotton famine —or at least an impression of great shortage—prevailed, so that prices rose rapidly to 18 pence a pound in Liverpool. This price, under ordinary conditions amply sufficient to draw every bale to that market, did not prevent large stocks from being held at American ports and at interior plantations. By the spring of the following year, the bottom had fallen out of the market and prices declined two-thirds, reaching 6 pence a pound that April. It was estimated that the losses in the cotton trade during 1866 were several times greater than during any other equal period in its history. Naturally such fluctuations were prejudicial to legitimate manufacturing.[21]

In 1867 Massachusetts and Merrimac Valley mills were reported to be running at a loss, and unsold goods to the value of several million dollars were accumulated in the mills and warehouses at Manchester, New Hampshire.[22] Two years later, in the spring of 1869, Fall River and Rhode Island mills were obliged to curtail production.[23] In 1873, as was natural, cotton manufacturers suffered from the great panic, although not by any means as severely as iron and steel makers and producers of goods employed partly or largely in development work. When the price of cotton rose beyond the usual level, manufacturers held their production down to the immediate demands of the market, for fear of accumulating a surplus of high-cost goods which they might be forced to sell at a loss during the subsequent period of lower cotton. In fact, the instability of prices could be compensated for only by maintaining a wide average margin between cost of production and quotations to purchasers. Fair profits during a period of this kind can not be justly measured by the same yardstick as during a period when business conditions are stable and more or less predictable for a considerable period in advance.[24]

NEW ENGLAND COTTON CENTERS

New England's superiority in cotton manufacturing was not affected by the war, and the proportion of the country's active spindles in that section tended to increase. Mills were enlarged and the financing and control of groups of mills fell into the hands of single families or companies, though not to the same extent as during the later decades of the century. The Sprague family of Rhode Island was particularly prominent at this time in the cotton manufacturing business and its interests were reported to extend from Maine to South Carolina.[25] During the late sixties several large mills were promoted and erected at Lewistown, Augusta, and Biddeford in Maine. Manufacturing was prosperous along the Merrimac River where

[21] Donnell, *History of Cotton*, 550.
[22] *Scientific American*, XVII, 118, Aug. 24, 1867.
[23] *Scientific American*, XX, 283, May 1, 1869; XXI, 172, Sept. 11, 1869.
[24] *Cf. Commercial and Financial Chronicle*, XVII, 56, July 12, 1873; XVII, 88, July 19, 1873; XVII, 696, 699, Nov. 22, 1873.
[25] *Scientific American*, XVI, 73, Feb. 2, 1867; XVI, 246, Apr. 20, 1867; XVI, 327, May 25, 1867; XX, 55, Jan. 23, 1869.

French Canadians had already supplanted to a great degree native American operatives.[26] Lowell lost its rank as the "spindle city" of America before the end of the war decade; but this was not due to a decline of manufacturing at that point. Here, as at Lawrence and Manchester, new factories and extensions derived no advantage from the local water power, which was already fully utilized to operate existing machinery; consequently additional spindles and looms had to be run by steam. The continued growth of textile manufacturing at these points was therefore due to different causes from those that had influenced the erection of earlier mills; and with the growing dependence upon coal Fall River and other cities south of the Cape enjoyed the advantage of cheaper power.[27] Southern New England thus recovered the precedence in cotton spinning and weaving that it had held during the pioneer days of the industry and in some respects had never entirely relinquished. In 1868 Lowell had 484,000 spindles and Fall River had 508,000; but Lowell exceeded its rival by about 1,000 looms.[28] Only four years later, after a period of remarkable expansion in 1871–1872, Fall River had nearly twice as many spindles as its rival on the Merrimac.[29]

The manufacturers of the two cities were not competitors, as the northern New England mills continued to manufacture chiefly the heavier fabrics in which America had excelled almost from the inception of the industry, while Fall River and the neighboring centers produced mainly print cloths. While Lowell, Lawrence, Manchester and the other great spinning towns of the northern New England states were built or promoted with capital accumulated in other lines of business and were financed by Boston merchants, the mills of Fall River and vicinity, at least until the boom of 1870, represented the gradually increasing wealth and investments of local manufacturers, who beginning on a small scale had in time expanded their operations until they reached very large dimensions. Originally encouraged by the presence of cheaply developed water power accessible to a harbor which permitted the direct unloading of cotton, coal and other materials almost at the door of the mills, the continued growth of the industry at these points, after these early advantages had ceased to be of determining importance, was due not only to tradition but also to a peculiarly favorable climate. The Gulf Stream approaches near enough to the North Atlantic coast in this region to prevent extremes of heat and cold, and to contribute a high degree of humidity to the atmosphere. So a condition unappreciated at first, and—if recognized—of minor importance at the time, eventually became a controlling influence not only over the growth of cotton manufacturing in this vicinity, but also over the special branch of the industry which was to develop there.

Partly because the mills at Fall River and vicinity were so largely owned by local capitalists, and partly because they produced mainly print cloths,

[26] *Textile Record*, III, 57, Mar. 1882.
[27] Massachusetts Board of Railway Commissioners, *Report, 1872*, pp. ccxxiv–ccxxv.
[28] *Scientific American*, XIX, 6, July 1, 1868.
[29] Peck and Earl, *Fall River and its Industries*, 64–65; Massachusetts Board of Railway Commissioners, *Report, 1872*, p. cix.

which are standard fabrics sold in large individual lots to a relatively restricted number of customers, the treasurers of these companies for the most part resided in the vicinity of the mills and took an active part in their management. This practice differed from that customary in the case of Merrimac Valley corporations, whose treasurers usually resided in Boston and devoted themselves principally to the financial and commercial end of the business.[30] As soon as the war was over a wave of prosperity spread through the textile manufacturing districts of New England, which was especially felt at Fall River and vicinity.[31] When the war closed, Fall River had but 265,000 spindles. Ten years later that number had quintupled. Between 1870 and 1872 alone, the number more than doubled and the latter year it reached almost 1,100,000.

This rapid increase led to the introduction of imported machinery, the demand for equipment being beyond the capacity of American shops to supply. In this way the English system of mule-spinning for both warp and filling gained a strong foothold. Mules were used elsewhere, if at all, only for spinning the weft, the warp being made universally on ring frames which were easily operated by comparatively unskilled female labor. Following the English mules came English spinners, bringing with them the trade unions and labor traditions of the mother country, with the result that labor conflicts were much more frequent during this period in southern New England than along the Merrimac. These difficulties accounted in part for the later restoration of ring spindles for spinning warp.

But the growth of cotton manufacturing during the first decade following the war was by no means limited to a few large centers. Many new mills, some of relatively small capacity, were erected at little manufacturing villages throughout New England. Yet for the most part even these new establishments would have been accounted large in any other part of the country. In 1867 the two eastern counties of Connecticut contained more than 60 cotton mills operating nearly 650,000 spindles and 11,000 looms.[32]

While cotton spinning was thus concentrating and expanding in New England, it was declining in the central Atlantic and western states. A 5,000-spindle mill was built at Chicago,[33] and some small establishments in the Ohio Valley may have resumed operations and increased their output; but the optimistic prophecies of great future textile centers in the West, which had been heard periodically before the Civil War, now ceased. Among the curiosities of the history of this industry is the record of a little cotton mill established in Utah by the Mormons, and another in operation during the sixties at Oakland, California. Both supplied local markets and used local fiber.[34] The comparative decline in New York, New Jersey and

[30] *Textile Record*, III, 143, June 1882.

[31] *I. e.*, Despite brief set-backs, as in the autumn of 1866: *Cf. Report on the Affairs of the Franklin Company, of Lewiston, Maine*, 1879, p. 56, in Harvard University Library; *Textile Record*, IV, 99, Apr. 1883.

[32] *Scientific American*, XIV, 128, Feb. 24, 1866.

[33] Webber, *Manual of Power*, 73.

[34] *Scientific American*, XVIII, 214, Apr. 14, 1868; Hittell, *Commerce and Industries of the Pacific Coast*, 479; *Commercial and Financial Chronicle*, XV, 72, July 20, 1872.

Pennsylvania was due in part to the war itself, which had shifted labor and manufacturing plants to other branches of production.

REVIVAL IN THE SOUTH

We have already referred to the fact that during the Civil War the cotton mills of the South were destroyed or reduced to a state of dilapidation by protracted use without repairs. Considering the economic prostration of that section, the revival of interest in this branch of manufacturing was surprisingly prompt and energetic. Doubtless this was due partly to a vivid realization of the fact that merchants' shelves were bare of cotton fabrics, not only in the former Confederate states but also in many other markets. The mills at Petersburg were in active operation before 1867, and in 1873 there were eight spinning establishments in that town or its immediate vicinity, employing altogether some 2,000 white operatives, and managed for the most part by Scotchmen.[35] The little spinning mills of North Carolina, partly because they served mainly local consumers, have left but a faint record in the industrial annals of the period. Shipments of yarn and cotton cloth through Wilmington fell off between 1860 and 1870, but this may have been due to the increased use of a rail route to northern markets.[36] A company was organized at the conclusion of the war to erect, with local and New York capital, a cotton mill of 10,000 spindles at Kalmia, South Carolina. This enterprise, after being reorganized and experiencing other vicissitudes due to its inadequate original capital, ultimately became successful, and in 1869 was rated the largest establishment of the kind in the state.[37] The old Graniteville Factory came out of the war in a dilapidated condition, and in 1867 was heavily in debt. It likewise was reinvigorated by northern capital.[38] Altogether South Carolina had eleven cotton mills with over 28,000 spindles and 1,000 looms that year.

As early as 1867 the cotton mills at Augusta, to which we have already referred, were so successful as to receive special mention in the report of the Commissioners to the Paris Exposition as illustrating conditions favoring cotton manufacturing in the South.[39] The mills at Saluda, destroyed by the war, had been rebuilt, and several little mills were running in the Greenville district.[40] Within less than two years of the conclusion of hostilities, the mills at Columbus, Georgia, which had been burned during Wilson's raid, were also under reconstruction.[41] About the same time,

[35] *Scientific American*, XVI, 302, May 11, 1867; King, *The Great South*, 582.

[36] King, *The Great South*, 472; Webber, *Manual of Power*, 73; Tompkins, *History of Mecklinburg County*, I, 181.

[37] *De Bow's Review*, Post Bellum Series, II, 49, July 1866; V, 198–199, Feb. 1869; *Scientific American*, XVI, 19, Jan. 12, 1867; XVI, 327, May 25, 1867.

[38] Kahn, *The Cotton Mills of South Carolina*, 19.

[39] United States Commissioners to the Paris Exposition, 1867, *Reports*, VI (Report upon Cotton), 71.

[40] King, *The Great South*, 346–347; *De Bow's Review*, Post Bellum Series, III, 570, June 1867.

[41] *Scientific American*, XVI, 378, June 15, 1867; Webber, *Manual of Power*, 65; *De Bow's Review*, Post Bellum Series, III, 568–569, June 1867: for other mills in Georgia *cf.* Somers, *Southern States of America*, 66, 84, 91; Webber, *Manual of Power*, 73–74.

we hear of several little factories established in central Alabama and Mississippi, and two or three in Texas. In 1873 the Tallassee Mills, in Alabama, were operating 18,000 spindles.[42] After the war the small profits of trade at New Orleans, and the necessity of finding employment for the surplus population during the interval between the loss of the share of the old river traffic now diverted eastward through rail channels and the commercial expansion which was to come with the new development of the South and West, turned the attention of the people to manufacturing. In 1869 a cotton mill with 10,000 spindles was projected at this city, and three years later two such establishments were in operation there.[43] Toward the close of the decade, a general campaign in favor of manufacturing started in the South, similar to movements of the same kind at various periods before the war.[44] In 1869 several southern mills exhibited their products, mostly shirtings and sheetings, at the Annual Trade Exposition in Cincinnati.[45]

These beginnings were naturally very modest compared with the maturer manufactures of the North; for the states of the former Confederacy had barely recovered the ground lost during the war. What distinguished this development, which to superficial observers seemed to promise little, was the prediction it contained of greater things to come. Northern investors were already making tentative excursions into the southern manufacturing field. It was obvious that with the fairly abundant supply of native labor, suitable climate, ample water power, fair transportation, and immediate presence of inexhaustible quantities of raw materials, the rise of important cotton manufactures in that section could not be long deferred.[46]

In 1868 when the National Association of Cotton Manufacturers and Planters began to collect statistics of that industry, the northern states had 561 mills and 6,162,000 spindles, while the southern states had 82 mills and 218,000 spindles. The average amount of cotton consumed per spindle in the South was nearly double the quantity in the North, and the average number of yarn spun was about 13 in the former and 28 in the latter section.[47] By the following year the number of mills north of the Potomac had risen to 664, operating 6,359,000 spindles, while the number of mills in the southern states was 86, operating 225,000 spindles.[48] Altogether nearly 100 fewer mills were in operation than in 1860, although the total number of spindles had greatly increased. In 1870 the North had 738 mills operating 6,852,000 spindles, and the South had 109 mills operating 262,000 spindles. The total consumption of cotton by the 7,114,000 spindles in the country was estimated to exceed 881,000 bales.[49]

[42] King, *The Great South*, 334–335; *De Bow's Review*, Post Bellum Series, III, 312, Mar. 1867.
[43] Rightor, *Standard History of New Orleans*, 511; *Scientific American*, XX, 268, Apr. 24, 1869; King, *The Great South*, 54; Mitchell, *The Rise of Cotton Mills in the South*, 58, footnote 103.
[44] *Cf. De Bow's Review*, Post Bellum Series, VI–VII, 802–805, Sept. 1869; VI–VII, 928, Oct. 1869.
[45] *Scientific American*, XXI, 139, Nov. 9, 1869.
[46] *Cf.* United States Commissioners to the Paris Exposition, 1867, *Reports*, VI, 18, footnote.
[47] *Hunt's Merchants' Magazine*, LIX, 416, Dec. 1868.
[48] *Scientific American*, XX, 194, Mar. 27, 1869.
[49] *Hunt's Merchants Magazine*, LXIII, 390, Nov. 1870.

CHAPTER XI

MANUFACTURE OF WOOL, SILK, AND MINOR TEXTILES

RAW WOOL

The woolen industry received a greater stimulus from the Civil War than any other equally prominent branch of manufacturing, and wool-growing, which had been a declining or stationary industry east of the Mississippi between 1850 and 1860, suddenly became a preferred branch of farming. But this good fortune was regarded as insecure. Woolen machinery multiplied and wool consumption mounted so rapidly during the period of hostilities that many factory owners felt that their prosperity was abnormal and viewed with greater concern than those engaged in more stable lines of business the possible effects of peace. Furthermore the manufacture of wool was traditionally regarded as peculiarly sensitive to tariff legislation, for it was the only important textile industry whose raw materials were imported over an appreciable customs barrier in sufficient quantities to affect its general prosperity.

In 1861 duties had been so arranged as to give the manufacturer a theoretical increment of protection to countervail the higher tax upon imported wool levied by the new tariff law. This accorded with the general policy of accommodating protective duties to the taxes directly or indirectly paid by manufacturers in the form of duties or domestic imposts upon raw materials, and of excise taxes upon finished products.[1] In 1864 the duties on wool were readjusted, and again in 1867 they were revised. During these years a conflict of interests between wool-growers and manufacturers manifested itself on several occasions,[2] but legislation was shaped upon the whole by the dominant influence of the farmer electorate, and was directed toward preserving a branch of rural industry which in our eastern and central states was feeling increased competition both from the newer sheep country of our own West and from the great grazing areas of the southern hemisphere.[3]

Our farmers produced no combing wool, except as the improvement of machinery enabled American merinos, previously used exclusively for

[1] United States Revenue Commission, *Reports, 1865–1866*, p. 429.

[2] National Association of Wool Manufacturers, *Bulletin*, XIII, 9, Jan. 1883; *cf. id.*, II, 85–86, 93, Apr. 1870.

[3] Second Convention of the National Association of Wool Growers and Wool Manufacturers at Syracuse, *Report*, 20–21; National Association of Wool Manufacturers, *Bulletin*, III, 19, Jan. 1872.

carded fabrics, to be combed for making delaines. During the war manufacturers of light worsteds and worsted braid had prospered by using the long combing wools admitted free under the reciprocity treaty with Canada.[4] Within the decade immediately preceding the termination of that treaty, in 1866, our annual imports of Canadian wool rose in value from $30,000 to over $1,350,000, measured in gold at the place of origin, and their amount reached 5,500,000 pounds.[5] Manufacturers advocated or opposed Canadian reciprocity according as their individual interests were affected; indeed mill owners were at this time divided in their attitude toward all wool duties.[6]

Sentiment in favor of free raw materials owed its strength, particularly in New England, to the fact that during the decade between the tariffs of 1857 and 1867 coarse and burry mestizo wools from the Cape of Good Hope and South America were admitted to this country free or subject to a low duty of three cents a pound. Meanwhile the invention of burring machinery and the Crompton loom, both of which originated in America, enabled our manufacturers to use these wools to advantage, especially for making fancy cassimeres. A prosperous branch of cloth production was developed in New England, and to some extent in other eastern states, by the use of this material, much as the infant worsted industry was simultaneously fostered by the supply of Canadian wool.[7] Naturally the minimum duty of 10 cents a pound plus 11 per cent ad valorem levied upon mestizo wools by the tariff of 1867, which in view of their heavy shrinkage practically prohibited their use and reduced importations from 36,760 bales to 6,000 bales the first year the law was in operation, encountered vigorous opposition from the manufacturers principally affected.

The period of prosperity which wool growers had enjoyed during the war came to a sudden end in 1866 and 1867, when prices fell abruptly throughout the world. The downward movement seems to have begun and to have been most acute in the United States.[8] A factor in the situation especially depressing for American grazers was the increasing popularity of worsted fabrics, which helped to maintain the price of combing wools at the expense of the carded wools that formed the bulk of the domestic clip.[9] Flocks east of the Mississippi rapidly diminished, especially in the New England and North Atlantic states, though not enough to prevent a net increase of about one-third in the number of sheep in the entire country between 1860 and 1870.[10] Several causes combined to check the decline

[4] Hayes, *Memoirs of the Wool Industry*, 1865, 19–21.

[5] *Sen. Doc.* No. 80, 62d Cong., 1st sess., 883, 887.

[6] United States Revenue Commission, *Reports, 1865–1866*, 439, 463; National Association of Wool Manufacturers, *Bulletin*, II, 70, 85–86, Apr. 1870; V, 96–97, Apr. 1874; XIII, 9, Jan. 1883.

[7] National Association of Wool Manufacturers, *Bulletin*, XXV, 40–41, Mar. 1895.

[8] Wright, *Wool-Growing and the Tariff*, 194–196, 202; Cole, *The American Wool Manufacture*, II, 80–81; Special Commissioner of the Revenue, *Report for 1869*, p. iii.

[9] Hayes, *Memoirs of the Wool Industry, Statement of Facts Relative to Canada Wools and the Manufacture of Worsted*, 15; Wright, *Wool-Growing and the Tariff*, 233.

[10] Wright, *Wool-Growing and the Tariff*, 203; *cf. Scientific American*, XVIII, 18, Jan. 11, 1868.

of flocks west of the Alleghenies, although here likewise wool production fell off after the war. The center of our grazing industry was moving rapidly to the Far West and Southwest. Yet tariffs and the vicissitudes of the sheep farmers do not seem to have changed radically the proportion of domestic wool used by manufacturers. In 1864 it was estimated that 70 per cent of that consumed by American mills was of home growth.[11] This ratio apparently increased somewhat during the closing years of the decade, with the decline of imports already mentioned, although in 1872 it suddenly fell to about 62 per cent as a result of abnormally high purchases abroad.[12]

Upon the whole the question of raw materials, though harassing to the manufacturer in periods of legislative uncertainty, did not determine the prosperity of the woolen industry. Customs duties upon raw wool created artificial conditions to which mill owners accommodated themselves for the most part without ultimate loss. They concentrated upon the production of fabrics where the ratio between the duties on raw wool and those on finished goods afforded the maximum protection. The domestic clip, though limited in variety and not satisfying all the needs of a highly developed industry, was increasing fast enough to encourage a healthy growth of mill facilities. Meanwhile technical progress constantly enlarged the range of fabrics for which home fleeces could be satisfactorily employed.[13]

TECHNICAL PROGRESS

This was notably true in the case of worsted manufacturing, which was relatively backward in America as compared with England and France. In 1866 the Hamilton Mills at Lowell, having decided to establish a new department for making delaines, imported all their machinery from Great Britain.[14] Two years later the Washington Mills of Lawrence imported combing machinery from France that enabled them to use domestic merino wool for making worsted coatings. Simultaneously loom improvements were perfected in the same establishment that made our weaving machinery, in this branch of manufacture, probably the best in the world.[15]

American mills were more nearly abreast those abroad in respect to machinery for making carded fabrics than for making worsted; but despite opinions to the contrary[16] there is reason to doubt whether even in the former branch of the Industry they had fully kept pace with the march of progress. No notable improvement had been made in carding machinery

[11] National Association of Wool Manufacturers, *Bulletin*, III, 192–193, Apr. 1872.

[12] Wright, *Wool-Growing and the Tariff*, 197–198; National Association of Wool Manufacturers, *Bulletin*, III, 276, July 1872; American Iron and Steel Association, *Bulletin*, VII, 179, Feb. 5, 1873.

[13] *Cf.*, however, a very interesting letter on this subject by a Belgian manufacturer, in National Association of Wool Manufacturers, *Bulletin*, V, 80–84, Jan. 1874.

[14] *Scientific American*, XV, 4, June 30, 1866.

[15] National Association of Wool Manufacturers, *Bulletin*, I, 322–323, Oct. 1869; XVI, 102–105, Jan. 1886.

[16] United States Commissioners to the Paris Exposition, 1867, *Reports*, VI, 29.

for a generation.[17] The hand jack continued to be used for spinning in all our woolen mills until after the Civil War, although British manufacturers had discarded it in favor of mules a quarter of a century earlier.[18] This reversed remarkably the rule that automatic machinery was usually adopted early in America on account of the high cost of labor, especially as hand jack spinners were reputed exceptionally intractable and irregular workers. The retention of this comparatively primitive device was explained by the fact that most American mills required a great variety of yarns to fit the diversity of their products, and these could be spun to better advantage with jacks than with power mules, which were adapted to spinning uniform numbers. In other words technical progress had to wait until other phases of the industry had reached a maturer stage of development.

This maturity was already prophesied. Between 1868 and 1870 much attention was given to improvements and attachments designed to make the jack self-operating; but by 1875 power mules had almost entirely replaced it.[19] The result was to lower the cost of spinning and to increase the output per spindle by one half, while producing a better quality of yarn. Hand-loom weaving had practically ceased by 1870, except for making certain kinds of carpets.[20] Even the cabin loom of the frontiersman and mountaineer, which had clothed the people of many remote districts during the Civil War, was becoming rare. Nevertheless centrifugal forces continued strong enough to maintain a considerable dispersion in the wool manufacture, so that small and often technically primitive establishments survived and multiplied in many parts of the Union.

GEOGRAPHY OF THE WOOL MANUFACTURE

These smaller mills were especially numerous and aggressive in the region west of the Alleghenies and north of the Ohio River. In 1868 they were reported to number 557 in the seven states from Ohio westward to Iowa and Minnesota, and to have an average capital of less than $100,000.[21] Their products were mainly cassimeres, flannels, jeans, blankets and other carded fabrics suited for the local market. These neighborhood mills bought their raw materials at their doors, recruited their operatives from the surplus labor of the countryside, and sold their goods in many instances directly to the retailer or consumer. The wool grower might be a stockholder in the establishment that bought his fleeces, and he often obtained a better price for the latter at home than he could delivered in the Chicago market. Indeed the old custom of bartering wool for cloth still survived. "At

[17] National Association of Wool Manufacturers, *Bulletin*, I, 197, July 1869.
[18] North, *History of American Wool Manufactures*, 275.
[19] National Association of Wool Manufacturers, *Bulletin*, I, 196–197, July 1869; I, 305, Oct. 1869; II, 149, Apr. 1870; Cole, *The American Wool Manufacture*, II, 88–90.
[20] American Iron and Steel Association, *Bulletin*, X, 180, June 28, 1876.
[21] *Scientific American*, XIX, 214, Sept. 30, 1868; *cf.* American Iron and Steel Association, *Bulletin*, VIII, 333, Nov. 5, 1874.

several mills in the Northwest they are actually exchanging wool for cloth to the extent of 125,000 pounds of wool a year."[22] Thus the industry repeated in the West its history in the East a generation or more before; but with certain advantages of technique and organization that the mill owners of the earlier period did not possess.

About this time several conventions were held in the Central West where manufacturers displayed the products of their mills and discussed matters of common interest with each other and with attending sheep raisers. Such was the First Northwestern Woolen Exposition and Convention of Wool-Growers, held at Chicago in August 1868. On this occasion 1,500 different lots of goods were shown, including, besides the standard coarser fabrics, opera flannels, fine cassimeres and doeskins.[23] The following year a similar exposition occurred at Cincinnati, and the Wisconsin Woolen Manufacturers' Association held an annual meeting and display of goods at Milwaukee.[24] At the Third Annual Exposition of Western Woolen Manufacturers, which took place at Indianapolis in 1870, the goods "were not confined, as formerly, to products of clothing wool: many worsteds and ladies' dress goods of excellent taste and quality were exhibited."[25]

Several mills were in operation on the Pacific Coast, where wool-growing needed no artificial encouragement in order to prosper, and pioneers, prospectors and miners afforded a special market for coarse, substantial goods that could be furnished to best advantage by makers directly familiar with local needs. In 1867 six such mills, all relatively small compared with those of New England, were running in the state of Oregon, and a thriving industry existed in California, where Chinese operatives were employed.[26]

Whatever stimulus the little woolen and mixed goods mills of the South may have received from their monopoly market during the Federal blockade was more than counterbalanced by the subsequent economic disorganization of that section and the unsettlement of reconstruction. Here and there a manufacturer plucked up courage to modernize his machinery and tried to recover his old market,[27] but this halting revival did not contain such seeds of promise as strengthened the hearts of the men who were at this time laying the foundations for a future cotton industry.

Notwithstanding this active peripheral development, the wool manufacture of the country, measured quantitatively, was concentrating steadily near the North Atlantic seaboard, notably in Massachusetts, Rhode Island,

[22] National Association of Wool Manufacturers, *Bulletin*, III, 50–51, Jan. 1872.

[23] *Scientific American*, XIX, 122, Aug. 19, 1868; National Association of Wool Manufacturers, *Bulletin*, I, 67, Jan. 1869.

[24] National Association of Wool Manufacturers, *Bulletin*, I, 391, Oct. 1869; *Scientific American*, XX, 315, May 15, 1869.

[25] National Association of Wool Manufacturers, *Bulletin*, II, 217, July 1870.

[26] *Hunt's Merchants' Magazine*, LVI, 306, Apr. 1867; *Scientific American*, XVI, 35, Jan. 19, 1867; XVI, 73, Feb. 2, 1867; XVI, 246, Apr. 20, 1867; XVI, 346, June 1, 1867; National Association of Wool Manufacturers, *Bulletin*, I, 62–65, Jan. 1869; I, 159–160, Apr. 1869.

[27] *E.g. De Bow's Review*, Post Bellum Series, III, 223, Feb. 1867.

Connecticut, New York and Pennsylvania. Single factories in Massachusetts turned out an annual product whose value exceeded that of the goods made in an entire group of western states. By 1870 the largest of these establishments, the Pacific Mills at Lawrence, worked up 3,500,000 pounds of wool a year, or the same amount as the 379 establishments reported by the census in the South;[28] and Massachusetts manufactured more than one-third of the wool consumed in the United States.[29] Though many small mills survived in the East, the average number of cards per establishment there was three times as large as in the West and South. Eastern mills manufactured practically all the imported wool used in the country, and likewise all the shoddy. According to the census the latter formed a much larger constituent of cloths made in the Middle States than of those made in New England.[30]

AMERICAN WOOLEN FABRICS

Jeans, linseys and satinets, the staple fabrics of the pioneer age of American wool manufacturing, still contributed more than 50,000,000 yards per annum to the products of our mills, but they had already lost their old precedence in output statistics. Cassimeres and allied cloths now stood at the front, with flannels retaining second place; and worsteds, though they did not as yet bulk large in production figures, except for the single article of delaines, which were manufactured entirely in New England, already held a respectable place in statistical totals.[31]

With an enthusiasm characteristic of the trade-writing of the day, a correspondent thus described the progress shown by the display of American fabrics at the New York Institute Exhibition of 1869:

"No Axminster carpets, such as we have seen at the Fair, equal to the foreign in perfection; no poplins; no Italian cloths or lastings; no ladies' fancy cloakings; no upholsteries; nor many of the descriptions of dress goods, which appear in such variety and such beauty, could have appeared in an exhibition of American manufactures ten years ago. The exhibition of today shows not only the great progress which has been made in the production of new varieties, but also in regard to their perfection."[32]

Yet two years later another writer in the same city complained:

"As a rule the woolen factories of this country are making very poor goods; and the exceptions are not numerous and important enough to redeem the general product from suspicion and contempt. Some cotton is almost universally carded in with the wool, which, in itself considered, does not perhaps harm the fabric very much; but there are all sorts of other devices designed to spare the wool stock, and to give the piece an apparent body and firmness that do not really

[28] National Association of Wool Manufacturers, *Bulletin*, II, 258, Jan. 1871; III, 276, July 1872.
[29] *Scientific American*, XX, 138, Feb. 27, 1869.
[30] *Cf.* National Association of Wool Manufacturers, *Bulletin*, III, 276, July 1872.
[31] Ninth Census, *Industry and Wealth*, 631–633.
[32] National Association of Wool Manufacturers, *Bulletin*, I, 313, Oct. 1869.

belong to it. . . . . The great point of our textile manufacturers seems to be not, as it ought to be, to originate something new, to have something of their own which foreigners might well copy, but to imitate in a deceitful way something already originated abroad."[33]

Such testimony, on either side, was probably colored by the protectionist or free trade bias of the witness. The criticism last quoted appears also to have been directed at imitators of foreign fabrics, who made goods on special order at weaving shops immediately tributary to the New York market. In 1867 the judges at the Paris International Exposition granted medals of the highest class given for carded woolen goods to American manufacturers for what we are assured were "ordinary fabrics . . . not made especially for exhibition but the daily products of the mills."[34]

A fair summary of the limitations and merits of the American Woolen industry at that time appears in the report of the Commissioners of the United States to this Exposition. They pointed out that it could not be said to occupy "a national position" except in card or clothing fabrics; but claimed that "in nearly all these productions we can vie with any nation in excellence, soundness, and taste of manufacture, and in some of them in cheapness." As these were the only fabrics that a great majority of the population used, our mills pretty satisfactorily supplied the domestic market.

"In the whole range of fancy cassimeres, including the mixed goods of silks and wool, in style, taste, perfection of manufacture, and strength of material, we excel the English and nearly approach the manufactures of France. The same may be said of the whole range of flannels, colored and plain, and of the Esquimaux and Moscow beavers, which we have imitated from the Germans. In the low cost pilots, used as substitutes for the beavers, sightly to the buyer but trashy in wear, it must be admitted that we can hold no comparison with the English. In all the grades of woolen shawls which can be fabricated of American wool, we successfully vie in fabric and cheapness of price with the Scotch, who are confessedly at the head of this branch of manufacture. In the class of all-wool goods of light weight, made in all varieties of colors, denominated sackings and cloakings, and largely sold for women's wear, the fabrics are now sold in this country, at prices reduced to a gold standard, cheaper than any similar fabrics are sold in Europe. Goods of this character, displayed in the American quarter of the Exposition, and marked at their net gold prices, attracted great attention for their cheapness and constant applications were made for their purchase."[35]

Several influences account for the diversification of fabrics and the increased finish and attractiveness of their appearance frequently mentioned by writers at this time. Improved combing, spinning and weaving machinery and processes for dyeing yarns gave manufacturers better control

[33] *New York Evening Post*, May 5, 1871, quoted in National Association of Wool Manufacturers, *Bulletin*, v, 294–295, Apr. 1875.

[34] Hayes, *Memoirs of the Wool Industry*, Third Annual Report, 33–34; U. S. Commissioners to the Paris Exposition of 1867, *Reports*, VI (Wool and Manufacture of Wool), 24.

[35] United States Commissioners to the Paris Exposition, 1867, *Reports*, VI. 20–21.

of their materials, independently of the skill of their operatives, than they had previously possessed. Those materials were available in greater abundance and variety than before. A more discriminating market was rapidly being created by the extension of what had hitherto been upper class and largely urban standards of consumption to a majority of both the town and rural population.

The practice of mixing wool with other fibers was by no means novel, as the linsey-woolsey of colonial looms and the satinet industry of the early Republic testified; but the employment of mixtures primarily for pattern and color effect, and for placing within reach of a wide range of consumers fabrics that resembled goods otherwise confined to a limited circle of users, was new and was characteristic of the general market changes of the period.

Military life left a permanent imprint on American habits of personal consumption. The familiarity with lighter footgear acquired in army service weaned many a farmer boy from his former devotion to heavy top boots. Another of these influences was the popularity of knit underwear in place of the flannel garments and cotton-lined clothing that had formerly served its purpose. Our knit-goods industry took a leap forward during the war and never thereafter suffered a serious relapse. Simultaneously improvements in knitting machinery, that made it possible to shape and seam goods automatically, displaced hand labor and cheapened the product.[36] As a consequence, the manufacture of knitting yarns acquired new importance in the woolen industry.

Meanwhile the worsted industry was getting a firmer foothold. Passing from the exclusive production of yarns, braids and cotton-warp delaines established before the Civil War, it extended about 1870 to include goods for men's wear, thus entering a field hitherto practically monopolized, so far as domestic fabrics were concerned, by fancy cassimeres and allied cloths. Broadcloth, which had been the premier product of our mills a generation before, apparently ceased to be made for a time during the war; and though its manufacture was resumed on a limited scale soon after that event, it never regained its former position in the men's wear market.[37]

One of the first forms of worsted manufacture conducted in factories in the United States was spinning carpet warps; and the survival of hand-weaving in the latter industry continued to encourage the production of these yarns for the open market. Although power looms for weaving both ingrain and Brussels carpets were an American invention, and were employed extensively in the large New England factories, it was estimated as recently as 1870 that 7,000 people were occupied at Philadelphia in weaving carpets on hand looms.[38] This precedent may have had some influence on other branches of the worsted manufacture, especially in New Jersey and Pennsylvania. In any case the practice of spinning and weaving in sepa-

[36] Hayes, *Memoirs of the Wool Industry*, Third Annual Report, 36.
[37] Hayes, *Fleece and Loom*, 59–60.
[38] National Association of Wool Manufacturers, *Bulletin*, II, 112, Apr. 1870.

rate establishments seems to have been more common from the first among makers of worsteds than among makers of carded goods.

FLUCTUATING PROSPERITY

A person forming his opinion from one of the most abundant sources of evidence regarding the condition of the wool industry during the eight years which followed the war, the testimony presented to Congress and through various channels to the general public in support of a high tariff upon wool and woolen goods, might form the impression that the prosperity of manufacturers was constantly threatened, and that the latter kept their plants in operation under a dark cloud of impending ruin.[39] And yet amid very real uncertainty as to the effect of the Government's fiscal policy upon their profits and possibly upon their survival, they continued to put new capital into their business. It is not unusual to read in the commercial journals of the time, simultaneous announcements of shut-downs and the discharge of hands or at least of curtailment of production at one point, and of the incorporation of new companies and the opening of larger modern mills at another point, perhaps in the immediate vicinity.[40] Only by considering progress through a series of years are we able to judge whether a business was presumably remunerative and secure. Measured by this canon, the period following the Civil War was by no means an unprofitable one for our woolen mills.

To be sure there were depressing factors in the situation. Some of these were temporary and incidental to the termination of hostilities, such as the sale by the Government of great quantities of army clothing and blankets at prices below the cost of manufacture.[41] The stimulus given to expansion by war prosperity made woolen machinery increase faster than the population, leaving the country with a surplus of productive capacity, and this capacity was not always in lines suitable for ordinary civilian consumption.[42] Also the fall in the price of wool in 1867 brought losses to manufacturers, just as the rise in prices after the declaration of hostilities had brought them profits. Evidence was presented about 1870 to show that woolen goods were being sold cheaper, in gold values, than ten years previously, although the general price level had risen decidedly during the interval.[43] Probably the sag in wool prices was the most unsettling influence in the industry before the panic of 1873; and it was apparently felt more by the large eastern factories that used imported wool and domestic stocks contracted for in advance than by the smaller establishments of the West. The big Washington Mills at Lawrence passed their dividends in

[39] *Cf.* National Association of Wool Manufacturers, *Bulletin*, II, 7, Jan. 1870; III, 344–345, Oct.. 1872; *cf.* American Iron and Steel Association, *Bulletin*, XIII, 147, June 11, 1879.
[40] *E.g. Scientific American*, XVI, 327, May 25, 1867; XVI, 346, June 1, 1867.
[41] National Association of Wool Manufacturers, *Bulletin*, III, 241–243, Apr. 1872.
[42] National Association of Wool Manufacturers, *Bulletin*, I, 293, July 1869; V, 12, Jan. 1874.
[43] National Association of Wool Manufacturers, *Bulletin*, II, 17, 32, 62–63, Jan. 1870; II, 451, Apr. 1871; III, 26, Jan. 1872.

1871, after paying but 4 per cent the previous year. On the other hand, the Pacific Mills in the same city, which manufactured principally delaines, continued to distribute liberal profits to their owners, maintaining an average dividend rate of 18.3 per cent for the decade.[44]

But despite minor and seasonal vicissitudes the general tone of the industry during this period was hopeful. In 1871 witnesses not inclined to exaggerate the well-being of mill owners declared the concurrent testimony to be "that, as a whole, the wool manufacture is prosperous;" that such depression as existed was caused by "overproduction in certain branches of manufacture," and that the remedy was to change in these instances to other fabrics which the markets demanded.[45] Such optimistic expressions of opinion were not exceptional, but were characteristic of the era of prosperity and expansion in most fields of production that preceded the panic of 1873.[46] They were confirmed, moreover, by the statistics gathered from time to time by the National Association of Wool Manufacturers, formed in 1864, and by the Government.

According to the census, between 1860 and 1870 the number of sets of wool cards in the United States increased from 3,209 to 8,366 and the consumption of wool for carded fabrics rose from less than 84,000,000 to nearly 172,000,000 pounds, plus over 19,000,000 pounds of shoddy. To this must be added the worsted industry, the value of whose product multiplied between six and seven fold, while its consumption of wool rose from 3,000,000 to 17,000,000 pounds. Money measurements for these dates are distorted by the effect of war inflation, which had lowered the purchasing power of the dollar in 1870; but the nominal value of the product of the two branches of the wool industry combined increased from $65,596,000 to $177,495,000 during the decade.[47]

THE SILK MANUFACTURE

For several reasons silk manufacturing developed rapidly during the Civil War and reconstruction. Foreign silks were taxed heavily as luxuries and the premium on gold added still further to their cost.[48] Silk mills employed mostly women and children, and therefore drew upon a source of labor that was not diminished by hostilities; imports of raw silks from China and Japan were facilitated by the completion of the transcontinental railway; and the market for silk goods was expanding on account of the high price of cottons and other competing fabrics and the rising standard of popular consumption. When a new silk factory, including forty looms,

[44] *Hunt's Merchants' Magazine*, LXIII, 130, Aug. 1870; *Commercial and Financial Chronicle*, XI, 12, July 2, 1870; XI, 846, Dec. 31, 1870; *Bagnall Papers*, III, 1752.

[45] Second Joint Convention of the National Association of Wool Growers and Wool Manufacturers of the United States, at Syracuse, *Report*, 29.

[46] National Association of Wool Manufacturers, *Bulletin*, I, 86–87; II, 144–145, Apr. 1870; *Commercial and Financial Chronicle*, XVII, 699, Nov. 22, 1873.

[47] Ninth Census of the United States, *Industry and Wealth*, 630–633.

[48] *Scientific American*, IX, 9, July 4, 1863; XIII, 169, Sept. 9, 1865; Wyckoff, *American Silk Manufacture*, 41.

began operations at Bridgeport, in 1865, it was expected to give employment "to a class which had hitherto been unprovided for in nearly, if not all, the industrial establishments of the city."[49] Prior to 1870 importations of raw silk at San Francisco were insignificant; two years later they were valued at well toward a million dollars, or more than five times as much as those received at New York. All this silk was used at first by eastern mills, but this trade added stimulus to a short-lived interest in silk raising and manufacturing in California.[50]

Although some of the largest silk mills in the United States were in New England, especially Connecticut, the industry already showed a tendency to centralize at Paterson, New Jersey. That city was near New York and Philadelphia, both of which were consuming and distributing centers for the trimmings, braids and ribbons that at first were the chief products of the mills. Moreover the same conditions that encouraged the manufacture of cotton and woolen textile specialties in these cities and their vicinity applied also to silks. Merchants could procure special shades, colors and patterns from America more promptly than from across the Atlantic.[51] Paterson was further favored by abundant pure water, which is absolutely necessary in this branch of manufacture, and by cheap labor from the families of the men employed in the machine shops and locomotive works already established at that city.[52]

Silk weaving, which had been suspended for several years, was resumed at Paterson about the time the war began,[53] and by 1863 raw silk from the Orient was being woven there into dress linings, plain dress goods, flags, neck ties, ribbons and various combinations of silk and mohair, as well as manufactured into the sewing twists, braids and fringes that had been a product of its mills for nearly thirty years.[54] In 1865 an English inventor, who had perfected a loom that multiplied a weaver's output five or six fold, introduced the manufacture of silk plush for men's hats.[55] Soon after the war the largest dye house in America was erected at Paterson for the special purpose of dyeing silks, and about the same time a large silk-weaving company removed from Boston to Paterson.[56] In 1869 the Dale Manufacturing Company in that city imported skilled operatives from France and began to weave broad silks.[57]

According to the census, there were 86 silk mills in the country in 1870, of which 28 were in New Jersey and 23 in Connecticut. The latter state,

[49] *Scientific American*, XIII, 146, Sept. 2, 1865.

[50] American Iron and Steel Association, *Bulletin*, VII, 470, Oct. 22, 1873; Brockett, *The Silk Industry in America*, 82; *Scientific American*, XVI, 73, Feb. 2, 1867; XVIII, 166, Mar. 14, 1868.

[51] *Cf. Scientific American*, IX, 9, July 4, 1863.

[52] Brockett, *The Silk Industry in America*, 115.

[53] *Scientific American*, II, 171, Mar. 10, 1860.

[54] *Scientific American*, X, 67, Jan. 30, 1864; Mason, *The Silk Industry and The Tariff*, 44–45.

[55] *Scientific American*, XII, 354, June 3, 1865; XIV, 49, Jan. 20, 1866.

[56] *Scientific American*, XVI, 378, June 15, 1867; XVI, 134, Aug. 31, 1867.

[57] *Scientific American*, XXI, 27, July 10, 1869.

which was the chief seat of the sewing-machine industry, also took first rank in the manufacture of machine twist and of broad silks, while New Jersey and Pennsylvania were far ahead in the production of ribbons and trimmings. New Jersey, followed closely by Connecticut, led in value of product, New York, Pennsylvania, and Massachusetts ranking next in order. The total output was valued at over $12,000,000, a small sum compared with corresponding figures for the cotton and woolen industries, but about double the census total of 1860, and destined to grow rapidly during the next few years. In 1875, according to the Statistics of the Silk Association of America, the value of goods produced exceeded $27,000,000.[58]

FLAX AND HEMP

Flax and hemp continued to be spun and woven into coarse linens and bagging, both on household looms and at small mills, particularly in the West. During the period of high cotton just after the war, the coarse hempen cloth made in Kentucky was preferred by planters to lighter imported fabrics, because the covering was sold with the bale at cotton prices.[59] In 1869 Ohio produced nearly a million pounds of dressed flax, most of which was worked up in the state.[60] A few larger mills, making linens and linen thread and using imported flax, were in operation on the Atlantic coast. The principal establishment of this kind was at Passaic, New Jersey, in the vicinity of Paterson, which had been a flax manufacturing center more than half a century before.[61]

[58] Ninth Census, *Industry and Wealth*, 624; Brockett, *The Silk Industry in America*, 155.
[59] Somers, *The Southern States*, 61.
[60] Gephart, *Transportation and Industrial Development in the Middle West*, 85, footnote; *cf. Scientific American*, XVI, 302, May 11, 1867.
[61] *Scientific American*, XIX, 327, Nov. 18, 1868; *American State Papers, Finance*, IV, 100.

CHAPTER XII

MISCELLANEOUS MANUFACTURES

MANUFACTURES OF FOOD AND DRINK

No marked technical change occurred in flour-milling during the period of war and reconstruction. In 1866 what was considered the largest mill in the country was built at Newark. It contained twenty runs of stones and had a capacity of 2,000 barrels of flour a day.[1] The following year the American commissioners to the Paris Exposition, where Austrian flour took the highest award, reported that the roller process already adopted in that country would "prove a money-making enterprise to whoever will introduce it into the United States;" but no one acted upon this hint until several years later.[2]

In 1870, according to the census, New York, Pennsylvania and Illinois ranked first, second and third respectively among the states in the value of flour produced. They all raised winter wheat, and the only premonition of the movement of commercial milling toward the spring-wheat belt that was to characterize the two following decades was the growth of a flour-manufacturing center at Minneapolis, with a monthly output approaching 90,000 barrels.[3] This was coincident with a decline of the same industry at Chicago.[4] But Minnesota still fell far behind many of the older states, like Virginia, in the total value of its flour-mill products. Indeed by 1870 Richmond had so far recovered from the war as to regain its old position among the important milling centers on the Atlantic seaboard. The Gallego Mills in that city, which had been for half a century as famous in their way as the Tredegar Iron Works in a different field, produced 1,500 barrels daily and had almost a monopoly of the thriving trade with Brazil and Australia.[5]

During the war the packing business had become still further concentrated in the West, and before 1870 the use of ice-cooling was beginning to change it from a seasonal to a continuous industry. This development created a revolution, not only in the packing trade but also in grazing and

[1] *Scientific American*, xv, 333, Nov. 17, 1866.

[2] United States Commissioners to the Paris Exposition, 1867, *Reports*, v, 11; Robinson, *The Wealth of Minnesota*, 103–104.

[3] *Scientific American*, xix, 231, Oct. 7, 1868.

[4] Bogart and Thompson, *The Industrial State*, 397.

[5] King, *The Great South*, 631–632.

stock farming. Farmers were relieved of the necessity of hurrying their hogs to market at a particular time or else losing the annual opportunity to sell. Better curing resulted through eliminating the haste and consequent carelessness with which meat was handled when the bulk of the year's work was performed during a short rush season. Farmers were able to control prices to some extent by holding back their stock when quotations were low and corn was abundant.[6] About this time beef packing began to move toward Kansas City, which proved a convenient center for drovers as long as there was free range from Texas to the grazing grounds along the Kansas and Missouri Rivers, and which benefited by the rapid construction of railways through the grazing states.[7]

While meat packing was becoming centralized even more than formerly in the West, the principal seats of the canning industry were Baltimore and Maine, where this business had originated with the preserving of oysters and lobsters. At Baltimore there were already two seasons: from September to June, when the canneries were employed in packing oysters, and from June until early autumn, when they were engaged in canning fruits and vegetables. The market for their products extended to China, Japan and Europe. Around this branch of food preparation had grown up a number of subsidiary industries. Nearly 30,000,000 cans were made annually in the city, half a dozen printing houses were occupied in making labels, and long lines of lime kilns converted the oyster shells into lime.[8] The canneries in Maine were more widely scattered, and there the pack alternated between lobsters during the spring and fall, and vegetables, especially green corn, during the summer.[9] Salmon packing, which had been begun on the Sacramento River by Maine canners in 1862, was by the end of the decade a thriving industry on the Columbia River, where the first cannery was established in 1866.[10]

In 1873 the sugar crop of Louisiana was less than one-third what it had been twenty years before.[11] The industry there had not recovered from the effects of war and emancipation; methods of manufacture remained primitive, and several mills continued to be operated by horsepower. More than five-sixths of the sugar was made in the old style open-kettle houses.[12] Rice cultivation was encroaching upon that of sugar cane because it took less labor. Many little portable mills were used and animal cultivation was being introduced to take the place of hand hoeing.[13] This period of

[6] *Hunt's Merchants' Magazine*, LXI, 447–448, Dec. 1869; Bogart and Thompson, *The Industrial State*, 394–395.

[7] *Commercial and Financial Chronicle*, XIII, 624, Nov. 11, 1871; Clemen, *American Livestock and Meat Industry*, 173–175.

[8] *Hunt's Merchants' Magazine*, LVI, 298, Apr. 1867; King, *The Great South*, 754.

[9] *Scientific American*, XIX, 294, Nov. 4, 1868.

[10] Collins, *The Story of Canned Foods*, 140–142.

[11] *Commercial and Financial Chronicle*, XXI, 409, Oct. 30, 1875.

[12] Bouchereau, *Sugar Report for 1868–1869* (First Report); *id.*, 1869–1870; *id.*, 1871–1872; Somers, *Southern States*, 222, 229.

[13] N. Walker in Rightor, *Standard History of New Orleans*.

depression continued with little change until the first Cuban revolution curtailed our normally heavy imports from that island.[14]

Beet sugar, the manufacture of which had been attempted experimentally in the United States as early as 1830, became the object of revived interest during the late sixties. A German company purchased a tract of land in northern Illinois in 1866 and imported a mill from Germany. The next year, in spite of losses due to inexperience, this little factory produced some fifty tons of sugar.[15] About the same time a factory equipped with French machinery was started in Iowa, another was erected at Oshkosh, Wisconsin;[16] and a more ambitious plant was promoted in California.[17]

Among the reasons for the interest manifested in this new industry were the growing importance of beet-sugar manufacturing in Europe, which threatened at that time to compel the abandonment of many cane plantations in the West Indies, the depression of the industry in Louisiana after the war, and the successful introduction of the diffusion process, which, it was anticipated, would give beet sugar an additional competitive advantage over sugar made from cane.[18] The manufacture of glucose was established at Buffalo shortly before 1870.[19]

Except for the fact that the tax laws adopted during the war encouraged the centralization of distilling in larger establishments than hitherto, no important change occurred in the manufacture of either malt or spirituous liquors at this time.[20] California already had extensive vineyards, and in 1870 it ranked second to Missouri in the value of wine produced.[21]

Before the Civil War the United States imported more than half the salt consumed in the country, and a strong prejudice existed in favor of English and Turk Island salt for preserving meat and other special uses. Our principal sources of domestic supply had been the Syracuse and Kanawha Valley wells, but during hostilities the rapid development of the Saginaw district and the destruction or abandonment of the Kanawha works as a result of military operations, concentrated along the Great Lake-Erie Canal artery a business that previously had been shared by the Ohio-Potomac highway. The fact that salt was to some extent a back-load for vessels taking grain and other western commodities to eastern markets from the Upper Lakes may have been a minor factor favoring Chicago as a packing

[14] *Cf.* United States Revenue Commission, *Reports, 1865–1866*, 139; United States Department of Commerce and Labor, *Statistical Record of the Progress of the United States, 1800–1907*, 28.

[15] *Commercial and Financial Chronicle*, II, 457, Apr. 14, 1866; *Scientific American*, XV, 64, July 28, 1866; XVI, 164, Mar. 9, 1867; XVI, 302, May 11, 1867; XX, 315, May 15, 1869; *De Bow's Review*, Post Bellum Series, IV, 219, Sept. 1867.

[16] *Scientific American*, XIX, 294, Nov. 4, 1868; XX, 315, May 15, 1869.

[17] *Scientific American*, XVIII, 70, Feb. 1, 1868; XXI, 8, July 3, 1869; Blakey, *The United States Beet Sugar Industry and the Tariff*, 32–34; Rolph, *Something About Sugar*, 148–151.

[18] *Scientific American*, XX, 57, Jan. 23, 1869.

[19] Ninth Census, *Industry and Wealth*, 512, 554.

[20] *Cf.* Bogart and Thompson, *The Industrial State*, 406–407.

[21] Ninth Census, *Industry and Wealth*, 451; *Cf. Scientific American*, XVI, 302, May 11, 1867; XIX, 1, July 1, 1868; United States Commissioners to the Paris Exposition, 1867, *Reports*, V, 21–28.

center. Partly as a result of the high tariff on salt domestic production grew faster than importations; but foreign salt continued to be used extensively along the seaboard, partly because it benefited by low sea freights, and by the inertia of an established trade.[22]

PETROLEUM

Among the reasons contributing to the decline of the salt industry in the districts directly tributary to the Ohio was the discovery of petroleum, which diverted the attention of producers to a new and more profitable pursuit. The latter bore to the older enterprises of western Pennsylvania and the adjoining states a relation that suggested, with due allowance for great differences in the character of the two communities, that of bonanza mining to the soberer economic activities of California and the Far West. In 1864 and 1865, according to popular report, petroleum yielded to the people of western Pennsylvania "a larger revenue than that derived from coal and iron."[23]

In sober reality the new source of wealth was wonderful enough to excuse some exaggeration. Pennsylvania's oil wells, with an investment of only $9,000,000, produced in 1870 petroleum to the net value of $13,000,000 above the cost of labor and supplies, while her coal mines, with an investment of $68,000,000, yielded a return above wages and materials of $16,000,000.[24] As early as 1865 there were 194 refineries in the United States with a yearly output of nearly 28,000,000 gallons. Pennsylvania had 80 of these, New York 46 and Ohio 26, principally at Cleveland. But the Ohio establishments were much larger upon an average than those elsewhere, and their total product exceeded that of any other state. This five-year old industry already paid into the Federal Treasury internal revenue taxes to the amount of over $5,000,000 annually.[25]

Pittsburgh promised at first to become the center of the new branches of manufacturing created by the discovery of petroleum. Its iron works supplied much of the tubing, machinery and other accessories for which oil fields called in rapidly increasing quantities. It was a focus of rail and river transportation, one of the greatest markets for lubricants in the country, and a secondary distributing point for the lard oil, candles and other packing-house products that were being displaced by the new commodity. In 1867 three refineries were in course of construction near that city, one of which covered an area of seven acres; and the following year $20,000,000 were said to be invested in the 58 refineries within its tributary territory.[26]

[22] American Iron and Steel Association, *Bulletin*, XVI, 210, Aug. 2, 1882; *Commercial and Financial Chronicle*, I, 164–165, Aug. 5, 1865; Special Commissioner of the Revenue, *Report for 1868*, 40–46.

[23] *Scientific American*, XV, 113, Aug. 18, 1866.

[24] Ninth Census, *Industry and Wealth*, 767, 769.

[25] United States Revenue Commission, *Reports, 1865–1866*, 257; Tarbell, *History of the Standard Oil Company*, I, 38–39.

[26] *Scientific American*, XVI, 327, May 25, 1867; XVIII, 215, Apr. 4, 1868; *cf. Journal of the Franklin Institute*, LXI, 117–122, Feb. 1871.

But oil flows down hill; the original fields were more accessible to the New York-Great Lake trunk lines; and an audacious spirit of enterprise was stirring at Cleveland. In 1868 the single refinery of Rockefeller, Andrews and Flagler, at the latter city, was producing 1,100 barrels a day, or well toward one-third as much as the whole Pittsburgh district combined.[27] Already petroleum had been discovered in California, and a refinery was in operation at San Francisco.[28]

Pipe lines had been laid from the wells to the railroads as early as the middle sixties, but the latter controlled all long-distance transportation. Tank cars were immediately devised to handle the new traffic.[29] Production increased faster than the market, in spite of a lively export trade, and between 1868 and 1873 the price of crude oil fell from 18 cents to under 8 cents a gallon. During the same period the price of refined oil fell from 34 cents to less than 18 cents, or below the price of crude oil five years before.[30] This condition had much to do with the organization, in 1868, of the Continental Improvement Company, and of its successor the South Improvement Company four years later, from which eventually emerged the Standard Oil Company. These combinations, which included both refiners and railroads, publicly proclaimed their purpose to control and regulate the market so as to secure a reasonable and steady profit for their members, and made no secret of their design to employ railway rebates for that end.[31] Whatever the cause, the margin between the prices of crude and refined oil did not vary as much as might have been expected during this period of acute decline.

The first great market for refined oil was as an illuminant, a field from which it expelled without much difficulty its long established competitors, whale oil, burning fluids and to some extent candles. It was almost equally indispensable as a lubricant, and the rapid mechanization of modern life would hardly have been possible without it. In both uses it naturally encountered some opposition and prejudice, and the controversy over its merits and demerits is recorded in a scanty but curious literature.[32] It was also employed at a comparatively early date as a steam fuel on vessels, both in California, where local petroleum was much cheaper than imported coal, and on the Great Lakes.[33]

VEGETABLE AND ANIMAL OILS

Although the American colonies had been for their day large exporters of flax seed to Ireland and Great Britain, and linseed oil mills were among

[27] *Scientific American*, XIX, 294, Nov. 4, 1868; Cone and Johns, *Petrolia*, 573.
[28] *Scientific American*, XVI, 3, Jan. 5, 1867.
[29] *Scientific American*, XV, 144, Sept. 1, 1866.
[30] *Commercial and Financial Chronicle*, XXII, 388, Apr. 22, 1876; *cf. Scientific American*, XVI, 73, Feb. 2, 1867.
[31] *Commercial and Financial Chronicle*, XIV, 313, Mar. 9, 1872.
[32] *Scientific American*, XVI, 37, Jan. 19, 1867; *cf. id.*, XV, 314, Nov. 3, 1866; XVI, 282, May 4, 1867; *cf.* Eaton, *Petroleum*, 234–235.
[33] *Scientific American*, XVIII, 406, June 27, 1868; XIX, 166, Sept. 9, 1868.

the commoner industrial establishments of that period, we depended chiefly upon foreign seed for our vegetable oils up to the Civil War. With the settlement of the prairie state, where flax proved an excellent crop for subduing wild land, we ceased to purchase from the East Indies the 3,000,000 or 4,000,000 bushels of seed we had previously imported; and our eastern oil mills closed down or curtailed their operations. Simultaneously new mills were erected in the West, where 10,000,000 bushels of flax seed were delivered annually at Chicago and other prairie markets; and instead of linseed oil being shipped West, the course of this trade was reversed, and the West began to supply oil to paint manufacturers and other consumers in eastern cities.[34]

While cottonseed oil had been manufactured in the South for a generation or more before the Civil War, the modern history of the industry began during the period of reconstruction. Both New Orleans and Mobile resumed the manufacture on a large scale after peace was established.[35] For the time being, however, the market was limited, and it was not until the following decade that the rapid expansion of the industry began. According to the census the cottonseed oil made in the United States in 1870 was something over one-third in quantity, and one-fifth in value, that of linseed oil.[36]

Whale oil and menhaden oil were manufactured on Long Island, and at various points on the New England coast. The latter oil was largely used for lubricating purposes; but the individual establishments were small and primitive, and the industry was not well organized.[37]

LUMBER AND NAVAL STORES

During the sixties the principal lumber-producing areas of the country, ranked by volume of output, were the Great Lakes white-pine region, including Michigan, Wisconsin and Minnesota, the still abundant Appalachian forests of Pennsylvania and New York, and northern New England. Michigan was our largest producer of sawed lumber; and according to the census of 1870 its mills cut nearly one-fifth of our annual output of about 13,000,000,000 feet. Pennsylvania and New York ranked second and third both in value and quantity of product.[38] The mills in these two states, and in the East generally, were relatively small and were usually operated by water power, while the western mills, and many of those in the South, were larger and were run by steam.[39] Railways were rapidly revolutionizing the industry. The Union Pacific and other prairie roads created new markets that so stimulated lumbering as to impel a prophet

[34] *The Textile Record*, III, 55, Feb. 1882.
[35] Somers, *Southern States*, 185–186; *De Bow's Review*, Post Bellum Series, VIII, 625, Aug. 1870.
[36] Ninth Census, *Industry and Wealth*, 618–619.
[37] *Scientific American*, XVI, 376, June 15, 1867.
[38] Ninth Census, *Industry and Wealth*, 613.
[39] *Cf. Scientific American*, XVI, 327, May 25, 1867; XIX, 102, Aug. 12, 1868; *De Bow's Review*, Post Bellum Series, VIII, 388–391, Apr.–May 1870.

to declare as early as 1869 that the forests in the upper Mississippi Valley "will all be cut down, and the land will remain desolate."[40] Simultaneously the rapid construction of railways through the South, during the period of reconstruction concessions and financing, opened the almost untouched yellow pine areas of that section to the lumberman. Shortly after the war forty or fifty mills were erected in the region tributary to Augusta, Georgia; and a number of large mills, representing an investment of several hundred thousand dollars, were built in northern Florida. In 1870 nine mills in the vicinity of Pensacola sawed 420,000 feet daily.[41] Mobile recovered its importance as a lumber port and four years after the conclusion of hostilities shipped nearly 4,000,000 feet from its wharves.[42]

A curious feature of the business at that time was the lively trade in oak timber assembled at Toledo and delivered by water routes to shipyards on the Atlantic coast. During 1867 more than a million cubic feet passed through that port for eastern destinations, and a fleet of ten or twelve vessels was engaged exclusively in this traffic.[43]

No technical improvement of first importance was introduced at this time. Band saws were employed for sawing imported cabinet woods so costly that every new economy in their manufacture invited attention; but no such motive appealed to the average sawmill owner, and a contemporary authority complained, "the waste of lumber in the United States is almost criminal."[44]

North Carolina easily retained her old precedence as a producer of tar and turpentine despite the disorganization of the war; and though the coastwise shipment of naval stores declined during the decade, this was doubtless due in part to the growing use of railways for transportation.[45] The industry was confined almost entirely to the South, and was widely distributed there, though important only in the two Carolinas. As a rule crude apparatus and processes were employed; yet as early as 1867 New Orleans had a "pine wood distillery" where pyroligneous acid, as well as turpentine, pitch, rosin and charcoal was produced.[46] But Connecticut seems to have been the principal manufacturer of this acid, or "wood vinegar," as it was popularly called.[47]

Every New England state increased the value of its lumber output between 1860 and 1870, but the manufacture of small wooden articles for a great variety of purposes was a more characteristic industry of that section.[48] A single factory in Burlington, Vermont, made 4,000 bushels of shoe pegs daily; a little factory district in Maine furnished two-thirds of

[40] *Scientific American*, XX, 307, May 15, 1869.
[41] *De Bow's Review*, Post Bellum Series, II, 48, July 1866; VIII, 462, May–June 1870.
[42] Somers, *Southern States*, 184.
[43] *Hunt's Merchants' Magazine*, LVII, 154–155, Aug. 1867.
[44] *Journal of the Franklin Institute*, LX, 3–4, July 1870.
[45] King, *The Great South*, 472.
[46] *Scientific American*, XVI, 407, June 29, 1867.
[47] Ninth Census, *Industry and Wealth*, 394, footnote (*a*), 499.
[48] Ninth Census, *Industry and Wealth*, 613.

the spools used in the United States; and Winchendon, Massachusetts, claimed to manufacture more woodenware than any other town in the world, its output amounting in value to over $1,000,000 annually.[49]

FURNITURE, VEHICLES AND PIANOS

Furniture factories were widely distributed, but in 1870 New York, Massachusetts and Pennsylvania were the three ranking states in this industry. Boston, New York and Philadelphia continued to make a large share of the high-grade furniture produced in the country. Cincinnati and St. Louis were also centers of this manufacture, and factories of some importance were beginning to develop in the hardwood region of Tennessee.[50]

The manufacture of farm wagons, freight wagons and pleasure vehicles was centered more largely than hitherto in the West, although New England and other eastern makers still had the reputation of turning out the best carriages and coaches in this country. About the period of the Civil War carriages with small front wheels, low axles, high bolsters and straight tongues and thills, which had been the style since colonial days, gave place to vehicles constructed on modern lines with the front wheels nearly as large as the hind wheels and curved shafts to make up the difference on the draught. Such carriages ran much easier than the older type.[51] The demand for freight wagons to be employed in hauling mining machinery and merchandise in the West increased rather than declined with the construction of railways through that section, and large works for making them were erected in Indiana and other western states.[52]

American buggies enjoyed a reputation as light inexpensive vehicles, both at home and abroad, that forecast in a modest way the later popularity of our cheap automobiles. Some English coach builders are reported to have advertised, in 1869, that they were prepared to build light carriages "on wheels imported from America."[53] The two-wheeled velocipede had a vogue in the late sixties, and a school for training prospective riders was opened in New York City.[54] We even hear of a convention of velocipede makers in that city, attended by representatives from all parts of the country except New England—where, incidentally, the largest shops for making them were located—to take joint action in certain litigation.[55]

American pianos, which created a sensation at the Paris Exposition of 1867 and were awarded two gold medals there, were not excelled by those of any other country.[56] Although the largest individual manufacturer in

[49] *Scientific American*, XVIII, 390, June 20, 1868; XIX, 310, Nov. 11, 1868; XX, 408, June 26, 1869.
[50] *E.g.*, *Scientific American*, XVI, 378, June 15, 1867; XX, 244, Apr. 17, 1869; XX, 315, May 15, 1869.
[51] *Scientific American*, XVIII, 169, Mar. 14, 1868.
[52] *E.g.*, American Iron and Steel Association, *Bulletin*, XXX, 251, Nov. 10, 1896.
[53] *Scientific American*, XX, 330, May 22, 1869.
[54] *Scientific American*, XIX, 407, Dec. 23, 1868.
[55] *Scientific American*, XX, 268, Apr. 24, 1869; XX, 404, June 26, 1869.
[56] United States Commissioners to the Paris Exposition, 1867, *Reports*, V, 13–14.

the world was Broadwood and Son of London, New York was probably the chief center of the industry. As early as 1865 that city contained seventy separate establishments turning out between 250 and 300 instruments a week.[57] The entire number made in the United States in 1870 exceeded 24,000 or probably more than were produced by any other country. The same year our factories manufactured an even larger number of "house organs;" the census reported nearly 29,000 of which about half were credited to Massachusetts and more than 3,000 to Vermont.[58]

CHEMICAL INDUSTRIES

Before the war the chemicals manufactured in the United States were limited to the commoner acids and salts, a few dyes and painters' colors, and pharmaceutical preparations. Indeed, outside of dyeing, few industrial chemicals were in demand. Sulphuric and nitric acid, which had been made in the East for half a century, were manufactured in California in 1867.[59] They were employed in the reduction of precious metals, and the establishments producing them did not represent a high degree of technical progress. Similar works had been among the half-dozen serious industrial undertakings ventured upon in Mexico during the period of economic stagnation under Spanish rule. Mining accounted also for the erection of powder works in the West. Until 1870 modern high explosives were not produced in this country, and mines, quarries and construction enterprises, as well as arsenals, used only black powder. Nitro-glycerine, manufactured on the spot, was employed in digging the Hoosac tunnel, which was opened early in 1875.[60] Acids were also made in connection with the fertilizer industry.

Many chemical works were associated with textile manufacturing. An establishment at Waltham, Massachusetts, which produced sulphuric acid and other chemicals, covered an area of eight acres.[61] The Rumford Chemical Works at Providence, which made phosphoric acid and baking powder, had become an establishment of some importance.[62] On Long Island, works were erected for extracting iodine and bromine from seaweed.[63] At the town of Jackson, in the Michigan salt district, a company began in 1869, to manufacture soda ash, sal soda, bicarbonate of soda, caustic soda, chlorate of potash and hydrochloric acid.[64] Two years earlier, we are told, not a pound of soda ash was made in the United States, although Detroit shipped to England large quantities of sulphurettes of copper, to be used for making soda ash in that country.[65]

[57] *Scientific American*, XII, 215, Apr. 1, 1865.
[58] Ninth Census, *Industry and Wealth*, 616.
[59] *Scientific American*, XVI, 327, May 25, 1867.
[60] Depew, *One Hundred Years of American Commerce*, I, 195.
[61] *Scientific American*, XIX, 22, July 8, 1868.
[62] *Scientific American*, XVIII, 201–202, Mar. 28, 1868.
[63] *Scientific American*, XVIII, 214, Apr. 4, 1868.
[64] *Scientific American*, XX, 364, June 5, 1869.
[65] *Scientific American*, XVI, 121, Feb. 23, 1867.

Philadelphia was the principal chemical manufacturing city of the United States and its products included the whole range from heavy acids to pharmaceutical preparations.[66] A Philadelphia firm had an establishment at the neighboring town of Chester for making extracts and concentrates of vegetable dyes, which with its storage yards covered fourteen acres and used dye woods from all parts of the world.[67] But aniline colors were already in the market. Popular science corners in the papers of the Civil War period contained frequent references to these new dyes and the mystery of their preparation.[68] At that time our textile manufacturers received magenta blues and violets of various shades, purple, yellow, orange and green from London.[69] About 1865 an English company established a factory for making these dyes at Williamsburg, on Long Island, with offices on Chambers Street, New York, where according to its advertisements it produced all the shades mentioned as well as browns and blacks for the use of "printers, publishers, manufacturers of paper hangings, lithographers, and others." Among the products of these works were picric acid, carbolic acid, wood naphtha, methyl spirits and nitro-benzol.[70] More than ten years later, however, we are told that all the colors produced in America were made from imported aniline.[71]

Between 1860 and 1870 the value of the fertilizers manufactured in the United States rose from less than $900,000 to nearly $6,000,000, and it practically quadrupled during the following decade.[72] Geologists had known for many years that phosphates existed in large quantities in South Carolina, but their commerical value was not recognized until 1867.[73] Immediately thereafter fertilizer works to utilize these supplies were erected both in the vicinity of the deposits and in the North. Most of the manufacturing, however, was done in the North Atlantic states though, as early as 1870, 19 companies were operating in the former Confederacy.[74]

LEATHER MANUFACTURES

Tanning is one of the oldest industries in America and leather has always ranked in value well toward the head of our manufactures. Furthermore our tanners have depended ever since colonial days upon imported hides to supplement the domestic supply, for an abundance of tanbark was originally one of the chief encouragements of their trade. These hides came mainly from the West Indies and South America, which subsequently supplied tanning materials as well. It was not until grazing extended to the western ranges, shortly before the Civil War, and railways and

[66] *Scientific American*, XVIII, 230, Apr. 11, 1868.
[67] *Textile Record*, III, 335–336, Dec. 1882.
[68] *E.g., Scientific American*, II, 68, Jan. 28, 1860.
[69] *Scientific American*, XII, 214, Apr. 1, 1865.
[70] *Scientific American*, XIII, 3, July 1, 1865; XVII, 62, July 27, 1867.
[71] Bolles, *Industrial History of the United States*, 494.
[72] *Manufacturers' Record*, lxi (1), 52, July 16, 1914; Ninth Census, *Industry and Wealth*, 395, 401.
[73] American Iron and Steel Association, *Bulletin*, XIX, 251, Sept. 16–23, 1885; *Scientific American*, XVIII, 394, June 20, 1868.
[74] Ninth Census, *Industry and Wealth*, 434; Somers, *Southern States*, 47.

canals enlarged marketing areas in the Great Lake and Mississippi Valley states, that commercial tanning centers of importance appeared in that part of the country. Milwaukee and Buffalo, which was said to have 60 tanneries in 1866 and drew its supplies of hemlock bark from the forests southward into Pennsylvania, were relatively large producers of leather in 1870, although for the most part this industry was still centralized near the North Atlantic coast.[75]

During the Civil War the heavy demand for leather tempted tanners to use hasty processes at the sacrifice of quality.[76] A similar demand arose in Europe during the Franco-Prussian war; and in response to it American sole leather began to be exported in appreciable quantities to the Continent, notwithstanding the prejudice European tanners, who used oak bark, had against our hemlock-tanned product, and having once gained a foothold abroad it held the market on account of its cheapness.[77]

Boot and shoe making, which had reached the factory stage by the end of the Civil War,[78] entered a period of rapid technical development immediately after that event as a consequence of improvements in power machinery. This added to the precedence of eastern Massachusetts in the industry. By 1866 Lynn contained 220 factories producing annually $12,000,000 worth of goods, and the yearly output of the state was valued at nearly $53,000,000. The latter figure rose to $88,000,000 four years later.[79] At the same time the growing production of leather in the West, and the distribution of army contracts during the Civil War, encouraged the manufacture of boots and shoes, especially of coarser grades, at interior points. Between 1862 and 1866 the number of shoe factories at Chicago increased from one to fifteen and the industry employed at the latter date 1200 hands and turned out 900 cases a week. Detroit had 20 manufacturers in 1868, whose aggregate annual output was valued at $6,000,000. The business also expanded at Baltimore and other places serving the southern market.[80] St. Louis had not yet attained the prominence in that industry which it has since acquired, but it was already an important center for the manufacture of saddlery.[81]

In 1864 the McKay sole-sewing machine was finally perfected by Lyman Blake of Massachusetts, after six years of improvement upon the original design. To be sure, even in 1866 machine-sewed soles were still imperfect, and if exposed to dampness the outer sole often ripped off when it was

[75] *Manufacturing Interests of Buffalo*, 63; Ninth Census, *Industry and Wealth*, 610, 699, 744.

[76] *Scientific American*, XVI, 279, May 4, 1867.

[77] *Commercial and Financial Chronicle*, XIV, 345, Mar. 16, 1872; United States Commissioners to the Vienna International Exhibition, 1873, *Reports*, I, 334.

[78] Hazard, *Organization of the Boot and Shoe Industry in Massachusetts before 1875*, chapter V, passim.

[79] *Scientific American*, XV, 428, Dec. 22, 1866; XVI, 327, May 5, 1867; XXI, 172, Sept. 11, 1869; *Commercial and Financial Chronicle*, II, 81, Jan. 20, 1866; Ninth Census, *Industry and Wealth*, 416.

[80] *Scientific American*, XIV, 365, May 26, 1866; XVIII, 294, May 9, 1868; XX, 331, May 22, 1869.

[81] *Scientific American*, XIX, 214, 262, Sept. 30 and Oct. 21, 1868.

scarcely worn. Ordinary shoe-repairers could not mend the machine-sewed soles of that day, as no welt was employed and the sewing must be done from the inside. Yet only a year later improvements in the devices for waxing the thread and regulating tension, so as to give a pull of 70 pounds on every stitch, had remedied these defects to a great extent; and the American machine-sewed shoes exhibited at the Paris Exposition were highly commended. At this date, we are told, the ruling patterns and styles of ladies' shoes were already American, not Parisian.[82]

PAPER MAKING

The rapid rise in the consumption of paper about the middle of the century stimulated the search for more abundant raw materials than were afforded by the rags and waste paper previously used. As a result the manufacture of chemical and mechanical wood pulp began in this country while the Civil War was in progress. The first large works were begun at Manayunk in 1864; but they were not finally completed until two years later. They were reputed to be the largest establishment of the kind in the world and were capable of producing daily from 12 to 15 tons of wood pulp. Paper mills forming part of the establishment made about 4 tons of straw pulp daily in addition. At this time news print paper was a mixture of the two materials, in the proportion of four parts of wood pulp to one of straw pulp. The process was already well perfected and almost entirely mechanical. Comparatively few workmen were employed in proportion to the extent and capacity of the works.[83] Straw was also used as a raw material for pasteboard; but this industry had been established in America some years before the Civil War.[84] Straw board was employed mainly in book binding, paper-box making, and for buttons. In 1867 paper mills were started at Buffalo and Chicago to use certain grasses for paper stock.[85] Okra was employed by a mill at Mobile and the cane brakes of the South were cut down, steamed, baled and sent to New England to furnish fiber for wrapping paper.[86] Pulp mills were also established in Maine.

Paper-making began at Oregon City in 1866 and the following year there was a paper mill in Colorado.[87] Western Massachusetts was the most important center of this industry, and in 1870 that state, followed closely by New York, led in value of product. Most writing paper and other papers of higher grades were made in the New England and Central At-

[82] *Scientific American*, xv, 46, July 14, 1866; xvi, 117, Feb. 23, 1867; xvii, 382, Dec. 14, 1867; American Iron and Steel Association, *Bulletin*, xv, 209, Aug. 24, 1861; *cf.* United States Commissioners to the Vienna International Exhibition, 1873, *Reports*, iii, 309–316; Washburn, *Industrial Worcester*, 241-246; Peto, *Resources and Prospects of America*, 145–147.

[83] *Scientific American*, xiv, 266, 277, Apr. 21 and 28, 1866; United States Centennial Commission, International Exhibition, 1876, v, *Report of the Judges of Group XIII*, 28–29; Weeks, *A History of Paper Manufacturing in the United States*, 227–230.

[84] Weeks, *A History of Paper Manufacturing in the United States*, 221–224.

[85] *Scientific American*, xvi, 73, 167, Feb. 2 and Mar. 16, 1867.

[86] *Scientific American*, xx, 187, Mar. 20, 1869; xxi, 27, July 10, 1869.

[87] *Scientific American*, xv, 64, July 28, 1866; xvi, 302, May 11, 1867.

lantic states, but the manufacture as a whole was widely distributed, 32 states sharing the 684 mills reported in the census.[88] Paper-makers enjoyed great prosperity during the early years of the war tariff, but their abnormal profits attracted so much new capital into the industry that it was sadly overdone, and by the end of the decade many manufacturers were in distress.[89]

Paper was used at this time for purposes that changes of fashion or the substitution of other materials have now rendered nearly obsolete. The Crane Mills, at Dalton, Massachusetts, made paper machine-belting, which was reported in 1868 to be employed successfully at several New England factories.[90] Paper collars were at the height of their popularity. During 1867 a single firm made 16,000,000 of them; and in 1870 there were 33 factories in the United States devoted to their manufacture. These establishments were scattered all the way from Maine to California and had a total product valued at over $3,000,000.[91] A writer of the day protested:

> "If you open the window of your hotel and look down into the court, dirty paper collars, torn and worn paper collars, collars new but burst at the button holes, collars of all styles and conditions, meet your first glance. If you take the wings of the express train and the depths of the White Hills pierce, you are certain to meet with paper collars in the most quiet and retired nooks."[92]

Meanwhile improvements in printing machinery helped to promote the consumption of paper through more enduring channels. During the war a Pittsburgh inventor perfected a press into which paper was fed continuously from a large roll, and which printed both sides simultaneously at the rate of 9,000 sheets an hour. By 1868 type-setting machines had reached the point where they were optimistically reported to be in successful operation. One of these early devices, an Alden machine, was used for a time in the office of the New York Tribune.[93]

GLASS AND POTTERY

In 1866 the glass-makers of America held a convention at Philadelphia to agitate for higher duties. They asserted that foreign makers could sell glass in the United States for less than the domestic cost of production.[94] Nevertheless their industry ranked among the older American manufactures, and it was expanding rapidly. Pennsylvania produced half of the country's total output as measured by value, but eleven states shared the 114 establishments reported by the census of 1870.[95] The most marked

[88] Ninth Census, *Industry and Wealth*, 463.
[89] Special Commissioner of the Revenue, *Report for 1869*, pp. cvi–cvii.
[90] *Scientific American*, XVIII, 6, Jan. 4, 1868.
[91] Ninth Census, *Industry and Wealth*, 428; Bishop, *History of American Manufactures*, III, 63–66.
[92] *Scientific American*, XIX, 169, Sept. 9, 1868.
[93] *Scientific American*, VIII, 374, June 13, 1863; XIX, 246, 258, Oct. 14 and 21, 1868.
[94] *Scientific American*, XV, 18, July 7, 1866.
[95] Ninth Census, *Industry and Wealth*, 439.

features of this period were the erection of several new furnaces in the West[96] and the first successful manufacture of polished plate glass in this country, at New Albany, Indiana. This enterprise, which followed but had only a casual connection with the earlier works at Lenox, Massachusetts, previously mentioned, experienced the usual vicissitudes of new industries, but eventually became the pioneer establishment of a thriving and powerful branch of manufacture.[97]

Pottery, like glass, had been made in America from the first days of settlement, and porcelain had been produced in a small way during the early decades of the century. But while the manufacture of coarser wares was making steady progress, the statistics of 1870 contain no reference to porcelain, nor do private records indicate that it was then made in America. Nevertheless an interesting, though not permanently significant, effort to produce either porcelain or a white ware of finer grade than was usually manufactured in the United States was made in the South shortly after the Civil War.

Porcelain clays, similar to those which had been imported from South Carolina into England by Josiah Wedgewood before the colonies became independent, had attracted a British manufacturer to that state before 1860, where he succeeded in making white ware. During hostilities his pottery manufactured telegraph insulators for the Confederate Government. Fire brick and a black ware, rude but strong, and shaped into grotesque patterns by slave workmen, were also made in the same vicinity. There was another small establishment at Milledgeville, Georgia. After the war the South Carolina pottery was revived and some porcelain, or at least high-grade white ware, was made at works in the vicinity of Augusta. The English workmen employed could not be persuaded to remain, however, and made their way north. Transportation of goods to market was costly, and it eventually proved cheaper to ship the clay to Northern points than to manufacture it where it was dug.[98]

Two important centers of the pottery industry already existed in the North. The oldest of these was East Liverpool, Ohio, where the manufacture was started in 1839. The other was at Trenton, where the modern industry began soon after 1860, drawing its clays from Pennsylvania and its feldspar at first from Connecticut. As the number of works increased, specialization was introduced, until almost every establishment had one peculiar line to which it devoted itself exclusively.

Artificial teeth of porcelain were made at Philadelphia and Baltimore, the former city being then as now the principal center for the manufacture of

[96] *E.g.*, *Scientific American*, XVI, 302, 327, May 11 and 25, 1867.

[97] *Scientific American*, XXI, 199, Sept. 25, 1869; Tenth Census, *Statistics of Manufactures*, 1136–1137. (The items in the Eighth Census, *Report on Manufactures*, 232, and in the Ninth Census, *Industry and Wealth*, 439, footnote, refer to rough plate glass.)

[98] Barber, *Pottery and Porcelain of the United States*, 186, 249; *De Bow's Review*, Post Bellum Series, II, 48, July 1866; *Scientific American*, XV, 143, Sept. 1, 1866.

dental supplies. At the Paris Exposition of 1867 those shown by American exhibitors were judged superior to any manufactured in Europe.[99]

Although roof and floor tiles, as well as enamelled tiling, had been made in Pennsylvania before the Revolution, building terra cotta was not manufactured in the United States until about 1870.[100] Another new industry of this period that was remotely related to the pottery trades was the manufacture of enamelled ware. The first black and white ware produced in America is said to have been made by a New York company in 1865. Agate ware did not appear among the products of domestic industry until eleven years later.[101]

CLOCKS AND WATCHES

Clockmaking exhibited little change, either geographical or technical, during the ten years that followed the Civil War. As a factory industry, it clung closely to its parent state, Connecticut; and it ranked with the manufacture of firearms and of sewing machines among industries employing highly standardized methods of quantity production. At the works of the New Haven Clock Company, which in 1868 turned out 150,000 timepieces per annum, almost entirely by automatic machinery, the cost of making an ordinary one-day brass clock was less than fifty cents.[102] But watchmaking, which had begun to copy the organization and technique of clockmaking, was at this time in a more dynamic stage of development. When the Civil War began the American Watch Company, which had erected a factory at Waltham, Massachusetts, was just ready to reap the fruits of eleven years of experimenting with automatic machinery invented and perfected by its founders and employes; and it had worked out, after many disappointments and setbacks, what was to be the American system of watch manufacturing.[103] This new refinement of interchangeable mechanism presented manifold difficulties in application, partly on account of the delicacy and accuracy of the machinery required, and partly because watchmakers and repairers were handicraftsmen unfamiliar with the engineering trades. Even those who had the insight to appreciate the possibilities of mechanical watch production, and the initiative to attempt it, failed for a time to realize that the machine shop was the foundation of the factory. It was not until they learned, through hard experience, that good mechanics were more essential to the success of the business in its new form than watchmakers, and had the rare fortune to bring into their firm a versatile individual who had previously been both a watchmaker and a machinist, that success smiled upon the Waltham pioneers.[104]

[99] American Commissioners to the Paris Exposition, 1867, *Reports*, v (Thomas W. Evan's report), 18.
[100] Barber, *Pottery and Porcelain of the United States*, 424.
[101] American Iron and Steel Association, *Bulletin*, XXXVII, 30, Feb. 25, 1903.
[102] *Scientific American*, XVIII, 330, May 23, 1868.
[103] Abbott, *The Watch Factories of America*, 16–17, 23–24, 28–31.
[104] Abbott, *The Watch Factories of America*, 19–21, 28–31.

Fortunately, too, the war created a new and seemingly unlimited market for watches; for every soldier in the army wished to own one. As a result of this demand for its products, the Waltham Company, which had been insolvent in 1857, was so prosperous by 1864 that its shares rose to four times their par value. During the next few years stock dividends and cash dividends of from 20 to 28 per cent upon the increased capitalization were declared; and the capacity of the factory, which was 150 watches a day toward the end of the war, was doubled about the time that peace was declared.[105]

So profitable an industry naturally invited competition. Soon after the cessation of hostilities several factories, many of which were short lived, were established in the East and the Central West. The more important of these, and practically all those that were permanently successful, were organized or managed by former Waltham employes. In 1867 the New York Watch Company, which owned a patent for a special escapement, started a factory at Springfield, Massachusetts. It immediately began to make stem-winding and stem-setting watches, which at that time were regarded as a novelty. After various misfortunes this company at length emerged on the highway of prosperity as the Hampden Watch Company.[106]

This enterprise was preceded, however, by the first similar venture in the West, the National Watch Company, organized at Chicago in 1864. Several former Waltham employes were among the promoters and stockholders in this undertaking. The company erected a model factory on donated land at Elgin, Illinois. It began actual manufacturing in 1866, and at first turned out only works, which were put up in tin cases and sold to the trade. Encouraged by the success of this enterprise, two other factories were soon afterward erected in the same state. The Illinois Watch Company, organized in 1870 by one of the promoters of the Elgin Watch Company, built a factory at Springfield, which went into operation early in 1872; and the Rockford Watch Company, organized in 1874, completed a factory in the town of the same name two years later.[107]

Among the curious episodes in the history of the industry during this period of expansion was the occasional migration of machinery from point to point, as if some magic existed in these wonderful and novel tools that required a favoring climate to work its charm. The equipment of a watch factory established at Newark, New Jersey, in 1864, was transferred to Cornell, Illinois, seven years later, and after three or four years sojourn in its new location was shifted to a third factory at San Francisco, where its owners proposed to run it with Chinese labor. Still later, after the

[105] *Scientific American*, x, 314, May 14, 1864; xviii, 341, May 30, 1868; xix, 22, July 8, 1868; *Boston Stock and Money Markets*, Century Edition, 211; Depew, *One Hundred Years of American Commerce*, ii, 542; Bolles, *Industrial History of the United States*, 230.

[106] *Scientific American*, xvi, 246, Apr. 20, 1867; xviii, 134, Feb. 27, 1869; Abbott, *The Watch Factories of America*, 71–73.

[107] *Scientific American*, xiv, 117, Feb. 17, 1866; Abbott, *The Watch Factories of America*, 55–58, 79, 83–84.

Chinese had proved a failure, the machinery was moved to another plant, in Berkeley, where it apparently found permanent repose at last.[108]

TOYS

German toys were already common enough in America to associate their manufacture in the popular mind with the land of their origin. But several branches of toy-making were well established in the United States. Connecticut, long our principal producer of tinware and light metal goods, turned to this pursuit as soon as manufacturers discovered that it afforded a profitable use for their scrap tin and copper; and they at once devised labor-saving machinery to enable them to compete with Europe. Thereupon they drove their German rivals out of this particular field. Quite naturally, too, wood-working villages in New England found toys a remunerative side line, and turned out quantities of children's wheel barrows, carts, rocking horses, sleds and the like. Patented novelties were also manufactured in Connecticut. Forestville was a center for toy steam-engines, steam-boats, fire-engines, and similar mechanical devices. Dancing negroes, hollow rubber birds and dolls that whistled when squeezed were first made in the same state. Pewter toys, including soldiers, which were very popular during the Civil War, were also of domestic make, but Germany was a strong competitor in this branch of the industry. Dolls were a large article of manufacture in New York, Boston and Philadelphia, although their porcelain and china heads were generally imported. During the late sixties Chinese and Japanese toys, especially tops, made their appearance in the American market.[109]

A mere prophecy of what was to become within a very few years a great industry first brightened the vision of mankind at this time. In October 1867, an experimental electric arc light was installed on the roof of the Barge Office, near the Battery, in New York City. The current was generated by a primitive dynamo run by a small steam-engine. During the next three decades the dynamo was to influence the future development of the steam-engine almost as much as it did methods of illumination and power transmission. This light, which had been preceded by one in a British lighthouse five years earlier, and by others shown at the Paris Exposition of 1867, was hailed as producing a brilliance "almost equal to that of the sun itself." Indeed the captain of a revenue cutter was reported to have testified "that he had read a newspaper by it at a distance of nearly six miles."[110]

[108] Abbott, *The Watch Factories of America*, 45–50.
[109] *Scientific American*, XVII, 277, Nov. 2, 1867; XVII, 329, Nov. 23, 1867.
[110] *Scientific American*, XVII, 162, Sept. 14, 1867; XVII, 297, Nov. 9, 1867; United States Commissioners to the Paris Exposition, 1867, *Reports*, III, 418.

CHAPTER XIII

RESUMÉ OF THE WAR AND RECONSTRUCTION PERIOD

LEGISLATION

During the Civil War financial necessities caused at least one new tariff act to be placed upon the statute books with every session of Congress; and after the conflict was over revenue considerations continued to be the primary influence shaping this legislation. Measures were at once taken to repeal the more burdensome internal taxes; but when it came to revising customs duties considerations other than fiscal at once came into play. Wool growers were particularly insistent on high duties, fearing for quite adequate reasons the speedy decline of the abnormal prosperity they then enjoyed. Iron and steel men were alert to defend their interests, and a number of less prominent industries were found to be affected adversely by various provisions of the taxing laws. The result was an almost continuous discussion of the tariff in Congress, although between 1867 and 1870 no general act went on the statute books. The law of the latter year was followed by an act to reduce both duties and internal taxes, which became operative on June 6, 1872. All this legislation was designed to accommodate the federal income to peace requirements in such a way as to disturb as little as possible the prosperity that our manufacturing, mining and agricultural industries were enjoying; but the very fact that such laws were foreseen encouraged agitation and lobbying in favor of particular lines of business likely to be affected. Interests that would have remained passive in normal times were stimulated to seek special favors from the Government or were aroused to protest against possible measures affecting their welfare.

Meanwhile the attention of the general public was directed largely to reconstruction and currency problems rather than to tariff questions.[1] Sentiment in favor of promoting industry was strong. State legislatures in several instances enacted statutes freeing from taxes for a term of years new manufacturing enterprises or else authorized towns or other local bodies to exempt from such burdens new industries located within their boundaries.[2]

[1] *Cf.* Hadley, *Economic Problems of Democracy*, 124.
[2] *E.g.*, *Hunt's Merchants' Magazine*, LX, 119, Feb. 1869.

THE PARIS EXPOSITION

In 1867 an international exposition was held at Paris on a more ambitious scale than its predecessors in the same city and in London in 1851, 1855 and 1862. The United States was officially represented, and although our manufacturers were less interested in foreign markets than their European competitors, many private firms placed specimens of their products on exhibition. The American department was the "poorest looking" because of its absence of display and the strictly practical nature of the articles shown. Nevertheless, much to the surprise of Americans and foreigners alike, several grand prizes were won by our exhibitors. The most notable deficiency in American goods was the failure to wed the fine arts to industry. We failed in respect to tasteful designs, although our manufacturers had begun to learn that beauty consists in form rather than ornament.[3] It was rather remarkable, therefore, that both of the highest awards for pianos went to the American makers Steinway and Chickering. Our arms-makers also received gold medals, for in this branch of manufacture the superiority of the United States was "recognized as indisputable." It was anticipated—and the anticipation was not disappointed—that our agricultural machinery would lead the world, nor was it unlooked-for that we should receive a gold medal for steam-engines. It came as a surprise to many that "perhaps the finest collection of machine tools to be found in the Exposition" should be from Philadelphia, and some incredulous protest was evoked from our disappointed European rivals when the gold medal for the best locomotive went to a New Jersey manufacturer. American sewing machines also took the highest rank among those exhibited.[4]

CURRENCY AND PRICES

Among the general domestic conditions having direct bearing upon industrial prosperity at this time, the currency situation probably ranked first. Post-bellum inflation involved both currency and bank credits. The amount of money in circulation had increased largely during the war and its purchasing power had more than correspondingly declined.

The primary economic effect of hostilities was the destruction of wealth, a destruction concealed from the general public by the fallacious prosperity which inflation temporarily produced. Private debts, except long-time loans upon mortgage security, were mostly liquidated, and as we have seen in an earlier chapter, cash payments took the place of the previous credit system. This revolution in commercial practice alone would have probably created a market for more money. During the war, our gold exports were not heavy, nor did our stock of the precious metals leave our shores until it was obvious that specie payment would not be immediately resumed. But "hard money" had already disappeared from circulation. Its place

[3] *Scientific American*, xv, 135, Aug. 25, 1866.
[4] United States Commissioners to the Paris Exposition, 1867, *Reports*, I, 290–300.

was taken by greenbacks, national bank notes, and the various interest bearing securities of the Government which had been made legal tender.

As soon as the war was over, Government bonds representing a large share of the national debt, which now approximated $2,675,000,000, were in the hands of the American people and our banks.[5] There was very little private or commercial indebtedness abroad. The successful conclusion of the conflict and the assured permanency of the Union suddenly restored the shaken confidence of foreign investors in our securities, and large quantities of American bonds were transferred at somewhat advanced prices to foreign owners. This operation increased the loanable capital of the national banks, which was at once invested in private loans and discounts. These steadily increased from 1865 to the panic of 1873. On June 30 of the former year the volume of such credit was less than $363,000,000. By the autumn of 1873 it had risen to $940,000,000. Private indebtedness had multiplied at an even faster rate.

This credit expansion as well as the increase of the currency must be borne in mind in considering other business phenomena of the period. The peak of our circulation before the war occurred just before 1857, during the speculative era preceding the panic of that year, when it reached $215,000,000. In 1866 the circulation exceeded $700,000,000, and it never fell below that sum subsequently, although it did not reach $800,000,000 until 1874.

Therefore, the nation's resources for financing industry and commerce had been vastly increased by the close of the war without a corresponding addition to the real wealth of the country. These resources continued to grow thereafter, mainly by the expansion of credit, due in part to the liquidation of the national debt held at home through its purchase by foreigners and to direct loans made by Great Britain—and to some extent by Germany, France and Belgium—to private borrowers in the United States.

Under the illusion that debts are assets, the nation believed itself exceedingly prosperous, and that condition of popular psychology undoubtedly encouraged much useful development which otherwise might not have been undertaken. Unfortunately, it also encouraged premature and wasteful development, involving diversion of the real capital of the nation to unfruitful purposes.

The effect of these conditions upon prices was modified by many special and local factors. For example, while most raw materials used in manufacturing remained at a higher level, estimated at about 33 per cent in currency above their cost in the first years of the decade, cotton declined, because the world supply of that commodity was sufficiently affected by the abrupt withdrawal of the American crop for a period, and its later restoration, to reverse the normal price trend.[6]

[5] Dept. Commerce and Labor, *Statistical Record of the Progress of the United States, 1800–1907*, 2.

[6] *Commercial and Financial Chronicle*, XIII, 761–762, Dec. 9, 1871.

Our war currency, like our war tariff, created new problems of post-bellum legislation, the solution of which, it was foreseen, would have a profound effect on business conditions. A thrifty crop of monetary fallacies was cultivated by various schools of half-educated politicians, both inside and outside of Congress. The sober business world knew that specie payments must ultimately be resumed; the wiser heads saw that the sooner it was done the better. But the people learn only by experience, and each generation must learn its lesson for itself. So we had to pass through the panic of 1873 and the long subsequent era of slow recovery and oft-defeated hopes before the war fever and its after-effects were finally expelled from the body economic.

Until the panic the scale of prices, especially for articles of ordinary consumption, averaged far above the level indicated by the gold premium, and the cost of manufacturing was so high as to forbid America's exporting to foreign markets. Although there was presumably more currency in circulation than the country needed, it was absorbed in speculation to such an extent that an acute money stringency often prevailed. Every time the resumption of specie payment was deferred, the feeling that it might be delayed indefinitely grew stronger, and the gambling element among business men increased its ventures and called for new funds.

To be sure, occasional notes of warning were heard, and these from high sources. David Wells pointed out that, calculated in gold values, the increase in savings-bank deposits had been less than usual. Somewhat influenced perhaps by his greater familiarity with New England, he noticed the decrease in farm stock and animal products, the fact that more people lived in one house in 1868 than in 1861, and that the increase in savings-bank deposits represented less than 7 per cent compound interest on the deposits at the outbreak of the war. This pessimistic appraisement of the effect of the conflict upon the nation's wealth has been disputed, and may be legitimately criticized in respect to certain details. But it does not misstate the general fact that in spite of our increased industrial activity and ambitious development projects after 1865, the nation's rate of material progress had been seriously retarded by the war and its aftermath.[7]

LABOR CONDITIONS

Labor was profoundly affected by war conditions. Not only did nominal wages increase with unexampled rapidity, but a large amount of shifting occurred from one employment to another and from one district to another. During the scarcity of workers when war industries were being pushed to the utmost and large numbers of men in the prime of life were drafted into the army, employers were ready to accept almost any applicant for work who offered, with the result that untrained and incompetent hands were entrusted with tasks that in normal times would have been given only to

[7] *Cf.* Special Commissioner of the Revenue, *Report for 1869*, xxiii–xxvi.

experienced mechanics. Immigration fell off during hostilities and at that period of our history a larger proportion than today of the new arrivals from Europe immediately sought homes upon the public land.

When the army was demobilized and war industries discontinued a temporary surplus of labor resulted. It was complained in 1866 that not only did the supply of workers exceed the demand, but that the labor actually employed produced more goods than the people were prepared to buy "at current prices." With words that remind us forcibly of the warning circulated after the World War, the business world was admonished—

"If all the producing resources of the country are to be employed it must be upon terms which will admit of the product's being sold at lower prices than at present. The moral of the existing surplus of labor is thus very obvious; it means lower wages and lower prices generally."[8]

Neither wages nor prices went down, however; and three years later we are told, following an inquiry into labor costs, that—

"The laborer appears to be less worthy of his hire than heretofore, and to have lost his interest in his work."[9]

The same conditions that encouraged the flow of capital from Europe to America after 1865, also encouraged the flow of population in the same direction. This movement continued to increase until the panic of 1873. During 1872, 449,000 foreigners landed in this country, three-fourths of whom were from Great Britain, Ireland, and Germany. Sweden and Norway contributed 25,000, while Italy and Austria-Hungary respectively sent about 7,000 and 6,000 to our shores.[10] British and German immigration approached a high-water mark at that period. Records taken at Castle Garden indicated a great majority of the newcomers during these years were agriculturalists.[11]

Most labor discussion at this period centered around wages, and between the close of the war and the panic more attention than ever before was given to wage statistics. A canvas made in 1868, and another confined to Springfield, Massachusetts, in 1875, indicated the rate of pay in most industrial employments had risen 50 per cent or more since 1860. By the latter date wages had declined somewhat in certain trades particularly active during hostilities. As the investigators pointed out, the increases had not been uniform in all vocations. In some the rate of pay had remained about stationary, while in others, as in the building trades, it had tripled within less than a decade. In general, wages did not keep pace with the rising cost of living, so that these increases were only nominal, while real wages

[8] *Commercial and Financial Chronicle*, III, 750–751, Dec. 15, 1866.
[9] Special Commissioner of the Revenue, *Report for 1869*, xxxiii.
[10] American Iron and Steel Association, *Bulletin*, VII, 363, July 16, 1873.
[11] *Scientific American*, XIX, 102, Aug. 12, 1868.

had in fact declined.[12] For example David Wells, in his report as Special Commissioner of the Revenue in 1868, estimated as the result of an elaborate calculation that while the cost of living had increased since 1860 about 78 per cent, wages had risen only from 60 to 70 per cent and the laboring population was really not as well off at the latter date as before the war.[13]

In spite of the increase in nominal wages, labor costs of production in Great Britain and the United States were thought to be more nearly equal than earlier in the century. Within the limits of the country, wages varied more widely than they do today. Sir Lowthian Bell, a distinguished British iron manufacturer and matallurgical engineer, who visited this country in the early seventies to study conditions of iron production, reported that he found the greatest uniformity of wages among furnace hands, where keepers earned in the neighborhood of $2 a day. Nevertheless at the charcoal furnaces of Alabama, they received less than $1.25. Furnace fillers were paid under $1 in Alabama, as compared with $1.25 in the North. Iron miners in the Lake Superior region earned twice as much as those in New Jersey and three times as much as those of Alabama. It was estimated that in spite of a considerable decline from the highest point during the war, the rates of pay in the iron trades were from 50 to 75 per cent higher than a quarter of a century before.[14]

Wage statistics gathered in New York in 1868 indicated that few mechanics earned as much as $25 a week, while common laborers received from $12 to $15. Skilled mechanics at Springfield, Massachusetts, many of whom were employed in the United States armory, earned from $2 to $3 a day. Women employes in Massachusetts cotton mills received from 80 cents a day in the spinning room, to $1.12 a day in the weaving shed. Wages were relatively higher in the woolen industry, where women workers earned up to $1.40 a day.

Very high wages were reported in a few occupations. For instance, blowers and flatteners in Pittsburgh glass factories earned $250 a month—some earning as high as $20 a day, while the melters in the steel works of that city were reported to clear from $20 to $22 a day.[15]

Although reliable figures do not exist to show the fluctuation in the proportion of women operatives employed in different manufacturing industries during the war and subsequently, occasional notices of conditions in particular towns or establishments indicate that female labor was extending its field of service during that period, though perhaps not more rapidly than at other times. It was considered an innovation deserving press comment when women were employed to do light filing in the manufacture of drills and other machine tools at New Bedford.[16]

[12] *Scientific American*, XVI, 34, Jan. 19, 1867; XVIII, 378, June 13, 1868; American Iron and Steel Association, *Bulletin*, IX, 201, July 9, 1875; IX, 370–371, Dec. 17, 1875; Special Commissioner of the Revenue, *Report for 1868*, Appendices, D, E, *id.*, *Report for 1869*, xxxii–xxxiii.

[13] Special Commissioner of the Revenue, *Report for 1868*, 14–15.

[14] American Iron and Steel Association, *Bulletin*, IX, 201, July 9, 1875.

[15] *Scientific American*, XVI, 3, Jan. 5, 1867.

[16] *Scientific American*, XVI, 62, Jan. 26, 1867.

Sir Thomas Brassey in comparing the efficiency of American and English operatives after his study of industrial conditions in America reported that he found English operatives when transplanted to America exhibiting as a rule more individual skill and efficiency than they had shown in the old country. He attributed this to their conviction that the higher rate of wages prevailing in America could not be maintained unless operatives displayed the utmost care and diligence. Comparing the textile operatives of the two countries, he said that in Providence a weaver would tend from four to eight looms, while in England he would operate but three. The English machines, however, were run at a higher rate of speed.[17]

A rapidly widening use of automatic tools tended to displace the skilled mechanics of an earlier period, who learned all the operations of their branch of manufacturing during a protracted period of apprenticeship. For a time these better trained men were missed, for machinery was far from as perfect as it is today and emergencies arose more frequently than at present that demanded the varied knowledge and skill of the highly trained manual worker. Yet it was argued that while the older generation was more fertile in expedients, more apt at devising makeshifts to meet emergencies, the specialists who were now coming on the stage were more skilful in their particular lines than the old hands who had spent fifteen or twenty years practising a dozen different processes.

> "The forger of tools can work and temper steel better than the blacksmith, who in one day forges the crank for a new mill, tires a wheel, and tempers a knife blade."[18]

Part of the criticism of the new generation of American machinists was due to the large number of half-trained workers whom the army gun-shops and private arsenals discharged at the end of the war and who were still imperfectly qualified to operate even a single machine. These men, incapable of doing journeymen's work and too proud to take apprentice positions, forced themselves temporarily into places that they were unfit to fill, with the result that they spoiled work and were speedily passed on from one employer to another.

TECHNICAL EDUCATION

While apprenticeship was declining, applied engineering was being raised to the dignity of a science. In 1862 Congress passed the Land Grant Act for the encouragement of engineering and technical training.[19] One or two schools had previously made a specialty of turning out engineers. Rensselaer Polytechnic Institute was already an old institution, and as early as 1851 Brown University, which graduated in 1853 A. L. Holley, one of

[17] Brassey, *Lectures on the Labour Question*, 69

[18] *Scientific American*, XVIII, 340, May 30, 1868; XX, 201, Mar. 27, 1869.

[19] *Cf.* New England Cotton Manufacturers' Association, *Transactions, 1901* (Niagara Meeting), 269.

the most brilliant industrial engineers the country has produced, had regular courses in "the theory and practice of mill work, including the elements and construction of machinery and the application of water power as a prime mover" and "the construction and theory of steam-engines."[20] But the real beginning of technical education in America dates from the period immediately after the Civil War.[21] The Polytechnic College of Philadelphia by this time had a School of Mines, a School of Mechanical Engineering, and a School of Civil Engineering, each with courses leading to the bachelor's degree. In 1868 the Worcester Free Institute of Industrial Science was founded, and the city of Chicago appropriated $25,000 to establish a polytechnic school in that city. Referring to the work done at Cornell University, then a young institution famous for its practical innovations, a writer observed in 1867:

> "The tide of opinion has of late been rapidly setting toward a more practical kind of education than has for a long time prevailed. The applications of scientific discovery have revolutionized the arts, and success in any department of industry is getting to depend more and more upon knowledge of fundamental principles. . . . . It has, therefore, become necessary to provide for the special education of youths in order to fit them for anything like a high station in any industrial department."[22]

Yet one of the pioneer officers of the same university, describing thirty years later conditions in 1871, when he undertook the work of training engineers, remarked that it was still difficult at that time "to receive from the employer the slightest consideration for the educated professional; while the so-called 'practical man' was attempting to lead as a general the industrial armies of the nation."[23]

NEW ENGLAND INDUSTRIES

No striking changes occurred in the localization of specific industries during the war and reconstruction era. Although the tendency toward geographical concentration continued, it was counteracted to some extent by the growth of urban population in what had previously been almost exclusively agricultural states and the rise of local industries at such points.

New England awoke to a clearer consciousness of its destiny as a manufacturing section. Immediately after the war, public thought in that section recurred to a topic which was already being debated in the fifties—its changed economic relation to the Union as a whole as a result of its increasing specialization in factory pursuits. In 1872 the Massachusetts State Board of Railroad Commissioners, in an analysis of industrial conditions in that state—and incidentally in New England as a whole—and of

[20] *The Laws of Brown University* (Providence, 1851), 7.

[21] United States Commissioners to the Paris Exposition, 1867, *Reports*, VI (Report on Education), 234–236.

[22] *Scientific American*, XVIII, 185, Mar. 21, 1868; XIX, 74, July 29, 1868; XIX, 133, Aug. 26, 1868; XIX, 150, Sept. 2, 1868; XXI, 57, July 24, 1869.

[23] New England Cotton Manufacturers' Association, *Transactions*, Sept. 1901, 112–113.

the resulting requirements for transportation, observed that while the wealth annually produced by the people of Massachusetts had multiplied more than four-fold between 1845 and 1865, and at the latter date amounted to well over half a billion dollars, the original branches of production from which the people had accumulated the basis of their subsequent wealth, namely, farming and fishing, had remained nearly stationary. Foreign commerce had not expanded materially. "On the other hand, manufacturing production in all its branches has undergone the amazing development of $326,000,000." The fishing towns were declining in population. Foreign trade, once distributed between several thriving ports, was now concentrated at Boston and even at that point it was in a languid condition.

"Meanwhile, within the twenty years referred to, the whole interior of the state has been revolutionized. Cities, towns and villages, devoted to almost innumerable branches of manufacturing industry, have sprung up in every direction and are increasing with wonderful rapidity. The State is thus becoming one vast workshop, sending the results of its labor all over the world."[24]

Indeed, this was not an inaccurate characterization of every New England state with the possible exception of Vermont. Between 1860 and 1870 the population of Maine remained practically stationary, but the value of its manufactured products more than doubled, and the number of operatives in its factories increased nearly 50 per cent.[25]

The variety of articles made in New England was as striking as the diversion of labor to shop and factory industries. Remote hill villages shipped out all varieties of wooden ware. The large river towns produced textiles and machinery for textile mills. Central Massachusetts from Worcester to Springfield was more largely engaged in the finer form of iron and steel making. Towns of eastern Massachusetts, which lacked water power for textile factories, engaged in the manufacture of boots and shoes. Western Connecticut was a land of brass workers, clockmakers and craftsmen in countless other trades where brass and copper, silver and nickel, were used.

MANUFACTURING IN THE CENTRAL ATLANTIC AND GREAT LAKE STATES

While no significant change occurred in the geography of manufacturing in the Central Atlantic states, the growth of some of the long-established industries in that section had been greatly stimulated by the war. Philadelphia easily retained its ancient primacy as the leading manufacturing center of the country. Indeed, it claimed immediately after the war to be the greatest manufacturing city in the world, except London, and its shops and factories annually produced more that $200,000,000 worth of staple goods. It was the commercial center of 260 cotton and woolen mills, and still had several thousand hand looms, and it contained the largest

[24] Massachusetts Board of Railroad Commissioners, *Report, 1872*, cxlvi–cxlvii; *cf. id., Report, 1870*, 24.
[25] Maine, *Senate Journal, 1885*, 45.

chemical works, publishing houses, locomotive works and machine shops in the country.[26] But this expansion was not confined to the Pennsylvania metropolis alone. Between 1860 and 1870 the population of the neighboring town of Chester multiplied four times; and at the latter date it had the largest shipyards in the United States and its varied industries included 25 textile mills and the Eddystone Print Works, which employed the female labor of the iron workers' families.[27]

During the war decade there was a marked increase of manufacturing at Buffalo, partly to give employment to the population during the winter months when lake navigation was closed.[28] The development of manufactures in what was until recently the New West was a subject of frequent comment at that period. In 1867 a manufacturers' convention was held at Cleveland to discuss a revision of the revenue laws and tariff legislation particularly affecting western industries.[29] Old towns like Zanesville, where mills had been established for half a century, were now centers of diversified industry. Among the 35 larger establishments of this Ohio City at the close of the war were flour mills, foundries and machine shops, rolling mills, glass factories, paper mills, woolen factories, breweries, tanneries, a cotton mill and a sash and blind factory.[30] Peoria, Illinois, derived great advantage from the coal lying beneath the town, which sold locally for $2 a ton, and already had 14 distilleries as well as 8 breweries and 4 vinegar factories. A starch factory and 8 flour mills completed the industries which owed their existence to Peoria's being a marketing center for grain and fuel, in addition to which it contained a pottery, a paper mill and 4 plow works.[31]

Cincinnati had been a manufacturing city of local importance since 1820, but between 1860 and 1869 the output of its shops and factories increased in value from less than $50,000,000 to more than $100,000,000, of which one-fifth consisted of iron and steel products. The packing trades had lost their previous importance, although the manufacture of soap, oils, leather and boots and shoes were among the leading industries.[32] Before the end of the decade St. Louis had over 300 factories, and produced nearly $50,000,000 worth of goods per annum; and Chicago was taking rank as one of the country's great industrial centers.[33]

Mill towns were springing up even farther west. At St. Anthony's Falls, where manufacturing had barely begun when the Civil War broke out,

[26] *Scientific American*, XIV, 86, Feb. 3, 1866; XVI, 302, May 11, 1867; XVII, 358, Dec. 7, 1867; XVIII, 54, Jan. 25, 1868.
[27] American Iron and Steel Association, *Bulletin*, IX, 259, Aug. 27, 1875.
[28] Wilkinson, *The Manufacture of Iron in Buffalo*, in Buffalo Historical Society, *Proceedings*, Jan. 25, 1864, 4–5.
[29] *Scientific American*, XVII, 310, Nov. 16, 1867; *cf.* American Iron and Steel Association, *Bulletin*, III, 337, June 30, 1869.
[30] *Scientific American*, XVI, 246, Apr. 20, 1867.
[31] *Scientific American*, XVI, 278, May 4, 1867.
[32] *De Bow's Review*, Post Bellum Series, VI–VII, 904–905, Oct. 1869; Cincinnati Board of Trade, *Semi-Annual Report*, Mar. 31, 1869; Maxwell, *The Manufactures of Cincinnati*, 1878, pp. 21–22.
[33] *Scientific American*, XV, 116, Aug. 18, 1866; XVIII, 182, Mar. 21, 1868; XIX; 71, July 29, 1868; XIX, 154, Sept. 8, 1868.

mills were in operation in 1867 making flour, lumber, woolen goods, paper and furniture.[34] Within 20 years of the discovery of gold in California the state's manufacturing establishments comprised woolen and cotton factories, iron mills, tanneries, powder mills, paper mills and cigar factories. There were chemical works and glass works in San Francisco, and the manufacture of plows, farm wagons and smaller implements of husbandry had been established.[35]

RECOVERY OF THE SOUTH

Naturally the history of manufacturing in the South during the reconstruction period differs from that in the old industrial districts of the North or in the rapidly developing virgin territories of the West. The speedy restoration of several little textile mills and iron works destroyed during hostilities testifies to the hope cherished by many southerners that the return of peace would inaugurate a new era of industrial expansion in that section. During the session of 1865–1866, the Legislature of Georgia incorporated 17 manufacturing companies, an evidence of a public interest in such enterprises that doubtless outran the possibilities of performance.[36]

Some years later a southern editor reviewing this period described the revival after the war as "so slow at first as to be almost imperceptible." The towns recovered more rapidly, perhaps, than the country from the distress and ruin of hostilities; many refugees moved into them from abandoned or semi-abandoned plantations. Uncertain labor conditions led to the subdivision of large estates, with the result that social attractions changed from the country to the towns. Families who in slavery times would have been found on large plantations now preferred to reside in urban centers. This general shifting of native managerial ability increased public interest in industries which could be conducted in the towns, and it is an interesting fact that a great majority of the factories and mills of this section were controlled and managed by men born and bred in the former slave states.[37]

In fact the economic recovery of the South was not so slow absolutely as a comparison with the later period of abnormally rapid development might lead one to infer.[38] During the last 35 years of slavery, Mecklinburg County, North Carolina, made no appreciable advance in either wealth or population; but both wealth and population doubled during the first decade after emancipation. To be sure this county was not typical of the lowlands where the plantation system attained its fullest development. In the early days of the Republic the Piedmont region of Virginia and North Carolina

[34] *Scientific American*, xvi, 246, Apr. 20, 1867.

[35] *Scientific American*, xvi, 346, June 1, 1867; xvii, 278, Nov. 2, 1867; xx, 203, Mar. 27, 1869; xxi, 155, Sept. 4, 1869.

[36] Georgia, *Acts of the General Assembly, session 1865–1866*, 130–157 *et seq.*

[37] Bruce, *Rise of the New South*, 148–151; *The Industrial South*, vi, p. 414, Nov. 1886.

[38] Somers, *The Southern States Since the War*, passim; American Iron and Steel Association, *Bulletin*, viii, 252, Aug. 13, 1874; *Scientific American*, xiii, 262, Oct. 21, 1865; xv, 80, Aug. 4, 1866, xv, 147, Sept. 1, 1866; xx, 294, May 8, 1869.

was a promising manufacturing section according to the modest standards of the time, with blast furnaces, rolling mills, foundries, nail works, rifle factories, woolen mills and other industries. During the succeeding slave-cotton era these enterprises languished or disappeared, but when emancipation came the inhabitants reverted spontaneously to the occupations of their grandfathers and great-grandfathers.[39]

In 1873 the annual value of Richmond's manufactures was estimated to be $15,000,000, one-third of which was represented by tobacco and cigars. The product of the city's iron works exceeded $4,000,000 annually, and its flour mills ground $2,500,000 worth of flour.[40]

RAILWAY EXTENSION

Improvements in transportation, especially by land, continued to influence in a revolutionary way the geography of our manufacturing industries by opening new markets and tapping new sources of raw materials, and by exposing establishments serving only local consumers to increasing competition from larger rivals in specialized industrial areas. The effect of the rapid expansion of markets at this time on account of railway construction is illustrated by the history of lumbering in the upper Mississippi Valley. In 1857 the production of this region was about 300,000,000 feet and saw milling was depressed because the output exceeded the demand. Ten years later the upper Mississippi mills sawed twice as much lumber as at the earlier date, and yet their business had become sure and remunerative. According to contemporary testimony, "the extension of railroads in the adjoining states and the construction of the Union Pacific are assigned as the causes of this unusual prosperity."[41]

The completion of the latter line had a decided effect upon many branches of manufacturing. It was made a condition of the aid extended by the Government that only American iron should be used in its construction, and this demand was large enough—or dramatic enough—to exercise a steadying effect upon the iron market. The completion of our first transcontinental railroad facilitated trade with the Orient, especially in commodities having high value in proportion to their weight. Raw silk from Japan and China, as we have seen, found its way to Paterson and the Connecticut Valley by this shorter and speedier channel of communication. The manufactures of our eastern states were laid down in California on relatively better terms in competition with those of other countries than when the Pacific coast had been served entirely by the sea. On the other hand some California products—notably wines and canned goods—eventually benefited by readier access to eastern markets.[42]

[39] *Cf.* Tompkins, *History of Mecklenburg County*, I, 152–153; American Iron and Steel Association, *Bulletin*, XXXVI, 124, Aug. 25, 1902.

[40] Virginia, *A Geographical and Political Summary*, 1876, 97.

[41] *Scientific American*, XX, 307, May 15, 1869.

[42] *Cf. Scientific American*, XXI, 203, Sept. 25, 1869.

When the Civil War arrested railway construction in the South, the fourteen slave-holding states had approximately 10,000 miles in operation. During the war there was little if any addition to this mileage, and in some places tracks were taken up to supply iron to keep other lines of greater strategic moment running. In spite of this, by January 1, 1867, less than two years after the conclusion of hostilities, these same states had well toward 17,000 miles of railway under construction or completed.[43]

Many of the new roads in the South and West formed trunk lines, and with their completion the newspapers of the period began to note hauls of unusual length. Late in 1867 railroad iron was delivered without transshipment from the Cambria Iron Works in Pennsylvania to points 500 miles west of Omaha and 1,500 miles from their point of origin. A year later through freight was shipped from Concord, New Hampshire, to Salt Lake City—a distance of 2,600 miles. One special train consisted of 20 carloads of Concord coaches. Moreover, the speed with which goods were delivered was constantly accelerated. Fast freight reached New York from New Orleans—a distance of 1,825 miles—in six days running time. Passengers could arrive in Massachusetts from California in about a week.[44]

With this increase of transportation facilities, the quantity of freight moved grew larger. In 1851, the freight traffic upon all the railroads of the country equaled 417 pounds per capita of the population; in 1866 this tonnage had reached 2,777 pounds per person. At the same time, there had been a very large expansion in the waterway traffic of the country.[45]

This growth of business and the economies of construction and operation that accompanied it caused a corresponding decline in transportation costs. The Pennsylvania Railroad handled 420,000,000 ton miles of freight in 1865 and charged an average rate of 2.665 cents a mile for moving it. By 1873 the quantity of freight carried had more than trebled, reaching 1,385,000,000 ton miles, and the average charge per ton mile had fallen to 1.416 cents. In other words the cost of moving this freight was more than $17,000,000 less than it would have been at the rate of eight years before.[46]

And yet the question of railway rates and service was already exercising the public mind. As early as 1867 responsible newspapers were advocating the public control of railroads. Freight charges were most unstable. Rate wars alternated with periods of excessive charges, during which the roads tried to recoup themselves for their losses from this unbridled competition. In 1869 rival roads at one time received as low as 25 cents per hundredweight for carrying freight from New York to Chicago. As soon as they came to an agreement, this rate was quintupled. Late in the summer of 1871 first-class rates from New York City to Chicago were reduced from 75 cents to 45 cents per hundredweight, and dry goods and boots and shoes

[43] *Hunt's Merchants' Magazine*, LVII, 174–175, Sept. 1867.

[44] *Scientific American*, XVII, 358, Dec. 7, 1867; XVIII, 294, May 9, 1868; XVIII, 374, June 13, 1868; XX, 379, June 12, 1869.

[45] *Hunt's Merchants' Magazine*, LX, 164, Mar. 1869.

[46] American Iron and Steel Association, *Bulletin*, XVII, 83, Mar. 28, 1883.

were carried from the eastern metropolis to Kansas City for $1.15 per hundredweight. The great trunk lines were accused of making these sudden reductions not only to take business away from their competitors, but also to encourage the annulling of long-time contracts with large shippers, sometimes extending over a term of several years, in the hope that after these contracts were surrendered in order to profit by the temporary reduction, rates could again be raised, so as to give the roads a better average return.[47] Meanwhile these uncertainties upset the calculations of those large manufacturers who either bought their raw materials or sold their finished goods at a distance and rendered competitive conditions uneven and uncertain for small manufacturers serving local markets.

It was during this period that the big trunk lines were consolidated and the independent operating company began to feature in American transportation history. In the late sixties the Vanderbilt system, embracing the New York Central, Lake Shore, and Michigan Southern, fused into "a continuous and harmonious" line between New York and Chicago, while the Pennsylvania Railroad secured a perpetual lease of the Pittsburgh, Fort Wayne and Chicago road, and thus completed a competing line under equal unity of management between the same terminals.[48] In 1867 the Blue Freight Line was organized to operate its own rolling stock, including refrigerator cars, upon the eastern roads; and during its first year of operation it moved 147,000 tons of merchandise.[49]

Sleeping cars were also controlled by an independent company that preceded and for a time, indeed, tried to exclude the Pullman Company from this business. This earlier organization, formed by a group of patentees, was known as the Central Transportation Company, and it operated in the North Atlantic and Northern Central states. It was charged at the time with being a ruthless monopoly, and the railroad companies were said to be as helpless as children in its hands.[50]

In the midst of these new problems and this general progress, odd reversions to earlier railroad technique occasionally occurred. In the late seventies several lines of wooden railroad were built, particularly in northern New York. One of these wooden lines, nearly 50 miles long, operated 20-ton engines at an average rate of 20 miles per hour. Such roads were not intended for general traffic but served mines or lumber camps.[51] Indeed, the substitution of metal for wood occurred very slowly in remoter sections of the country. Wooden cogs and wallowers continued to be used in southern cotton gins until after slavery was abolished.[52]

[47] *Scientific American*, XVI, 318, May 18, 1867; *Commercial and Financial Chronicle*, IX, 495, Oct. 16, 1869; XV, 177, Aug. 10, 1872.
[48] *Hunt's Merchants' Magazine*, LX, 465, June, 1869.
[49] *Hunt's Merchants' Magazine*, LVIII, 228–229, Mar. 1868.
[50] *Scientific American*, XV, 113, Aug. 18, 1866.
[51] *Scientific American*, XXI, 104, Aug. 14, 1869.
[52] Tompkins, *History of Mecklenburg County*, I, 180.

FACTORY CONSTRUCTION, PRIME MOVERS AND GENERAL PROGRESS

About the close of the war, the peaked-roof factory building, which had been practically universal since the first water mills were erected in America, began to give way to flat-roof construction, partly because the latter gave less opportunity to fires.[53] Sprinklers had been introduced at Lowell as early as 1845, but only in the packing rooms of cotton mills. During the sixties they were widely adopted throughout the larger factories of New England. The distributing apparatus was approximately the same as that employed today, but the earlier instalations were not automatic. They were so arranged, however, that the mills could be promptly flooded by opening a single valve.[54]

No radical improvements were made during this period in prime movers or in methods of power transmission. Natural gas, which for nearly half a century had been employed for illumination and to boil brine at salt wells, was apparently first used to generate steam for power at Erie, Pennsylvania, about 1866 or 1867.[55] Internal combustion engines, driven by an explosive mixture of air and illuminating gas ignited by an electric spark, were exhibited at the Paris Exposition of 1867, and the suggestion had already been made in America that "the vapor of benzine and other light hydrocarbons" might be used to propel machinery—a hint that naturally came from a country where such fuels were beginning to be abundant, but that it was left for Europe first to apply in practice.[56] Hydro-electric power was still a thing of the future, but attention was directed increasingly to the importance of water power as a public asset. In 1868 the State of Maine completed a systematic survey of more than 2,000 power sites with the object of encouraging manufacturers to locate within its territories. Steam engines were improved; one American type attained a speed, without injurious vibration, of 700 revolutions a minute; and higher boiler pressures and more economical cut-off systems were introduced.[57]

On the whole the years of war and reconstruction were a period of quantitative rather than qualitative progress. The times demanded an exceptionally large output of manufactures just when the raw material and the labor market were understocked.[58] But they witnessed the erection of one memorable milestone in our manufacturing history—the establishment of the Bessemer steel industry, and they saw the foundations laid for perfections and refinements in industrial processes that were to bear abundant fruit later.

[53] *Bagnall Papers*, II, 1450.
[54] *Scientific American*, XXI, 134, Aug. 28, 1869.
[55] *Scientific American*, XVI, 157, Mar. 9, 1867.
[56] *Scientific American*, XIV, 84, Feb. 3, 1866; *cf.* United States Commissioners to the Paris Exposition, 1867, *Reports*, III, 60–70.
[57] *Scientific American*, XIX, 230, Oct. 7, 1868; U. S. Commissioners to the Paris Exposition of 1867, *Reports*, IV (Steam Engineering), 55–57.
[58] *E.g.*, *Scientific American*, XX, 217, Apr. 3, 1869.

In measuring the growth of manufacturing between 1860 and 1870 all data expressed in money values, such as total products and capitalization, must be corrected for the depreciation of the currency at the latter date, and for other influences causing a marked rise of prices during the closing years of the decade. Since the original figures are only approximately accurate and in many instances rest on very unsubstantial bases—an inspection of the original census records for 1860 shows that the manufactures schedules were returned in an appallingly defective state and were arbitrarily corrected and completed from unindicated sources—even what we are accustomed to regard as our most authoritative compilations must be regarded as plausible assumptions rather than absolute statements of fact. An attempt was made to eliminate such sources of error, so far as the records permitted, in the introduction to the report on Manufactures of the Ninth Census. On a basis of this adjusted comparison, which is probably more accurate than any that could be made today, the country's manufacturing product increased during the decade between 1860 and 1870 about 52 per cent, or approximately twice as fast as the population.

CHAPTER XIV

BUSINESS CONDITIONS FROM 1873 TO 1893

GENERAL CHARACTER OF THE PERIOD

Between 1873 and 1893 the United States was rapidly attaining maturity as an industrial nation. In some respects this was from an economic point of view the golden age of our history. Uncle Sam could still give every man a farm and yet the privations and hardships of the frontier had largely disappeared. Taxes were low, federal finance was more concerned with surpluses than deficits, the public debt was rapidly reduced and the spiritual unity of the nation was gradually being restored after the violent severance of the Civil War. The flower of the nations of Europe was seeking homes on our western prairies. Consciousness of progress and an unclouded optimism as to the future were well-nigh universal. Invention was adding new comforts and conveniences to daily life. A healthy equilibrium between urban and rural population was still maintained. The traditional ideas and institutions of the nation, comprehended in the word "Americanism," remained intact.

On the other hand this material well-being and economic progress made the nation inattentive and neglectful of political and social evils. Measured by the standards of the next generation, laws for the protection of labor, for defending the public from undue encroachment by powerful corporations, for guarding the purity of the ballot and for insuring integrity in public office were inadequate and behind the standards of many other countries. These two decades witnessed the culmination of American individualism, of that youthful phase of our history that began when the Virginia and Massachusetts settlers shook off the trammels of British colonizing companies and proprietors to make their own fortunes in the wilderness, and ended when the frontier had vanished and the last great areas of public land were occupied.

THE PANIC OF 1873

Yet this period of material prosperity and progress had a gloomy dawn. Our panic of 1873 can not be associated as directly with foreign depressions as some of its predecessors. It was, at least in its genesis, a native phenomenon. Nevertheless that year found conditions in the United States and in Central Europe very similar. Germany, like our North, had recently

emerged from a victorious war, and like the North she came out of the conflict with an inflated credit and a redundant currency. There was this marked difference, however, in the monetary situation of the two countries. We had a paper currency. It was improving in form, to be sure, by the gradual displacement of greenbacks by national bank notes; but in either case it was sustained ultimately by the credit of the Government. This credit was steadily improving and a bond-backed currency inspired more confidence and was better protected from factitious fluctuations than ordinary fiat money. Nevertheless the currency was inflated, as indicated by the persistent premium on gold. In Germany, on the other hand, there was specie inflation. Indeed, the latter term seems first to have entered the popular vocabulary at that time. This specie inflation was due to the payment of the French indemnity, which made money abnormally abundant in Germany, raised prices remarkably, encouraged extravagance and speculation and, though it was followed by an increase of wages, caused labor unrest.[1] The unhealthy condition that thus resulted reached a climax late in 1873, when there was a sudden shrinkage of values on the Berlin stock exchange, precipitated by an earlier speculative collapse at Vienna, and accompanied by a period of acute business depression that communicated itself to all parts of Europe having close business connections with the German capital. The effect was felt to some extent in London, although not with sufficient force to induce a panic or even to cause a serious shock to the money market.

Nevertheless the effect was to tighten the purse strings of all European money-lenders, and to make it more difficult than it otherwise would have been for American promoters and railway builders, who were employing a large amount of foreign capital to continue their borrowings abroad. During the period of active speculation in Germany itself, the financiers and banks of that country had not invested largely in American industrial securities, although they held considerable quantities of our Government bonds. England had supplied most of the capital we procured from foreign sources during the years of expansion that concluded the reconstruction era.[2]

Although we were still on a paper-money basis, the banking situation was not unsound when the crash came in the autumn of 1873. Our financial institutions held ample reserves and they had not unduly expanded their credits, measured by what had been almost normal conditions for the past four years.[3] The summer of 1873 brought us abundant crops. We had been tying up capital over-rapidly, however, in fixed investments. We had built railways imprudently into new territories which did not

[1] Von Waltershausen, *Deutsche Wirtschaftsgeschichte*, 272–273; *Commercial and Financial Chronicle*, XVI, 614, 712–713, May 10 and 31, 1873; American Iron and Steel Association, *Bulletin*, VII, 491, Nov. 12, 1873.

[2] *Commercial and Financial Chronicle*, XVII, 582–583, Nov. 1, 1873.

[3] *Sen. Doc.* No. 538, 61st Cong., 2d sess., 4–5; *cf. Commercial and Financial Chronicle*, XVI, 541, Apr. 26, 1873; XVI, 816, June 21, 1873.

afford at once traffic enough to pay the fixed charges on the investment. We had stimulated the settlement of public lands until the excessive additions to our cultivated area glutted our markets with the products of the farm. The prices of agricultural produce fell, the purchasing power of rural buyers declined and the market for our manufactures was correspondingly curtailed.

The crisis came at the height of the textile manufacturing season, when goods were being manufactured for the autumn and winter trade. Since the Civil War had pretty well destroyed the long-credit system, factory owners no longer sold their goods on six-months or nine-months notes. Indeed that practice had been discontinued after the 1857 panic. Normally sales were for cash, which meant thirty days or thereabouts—long enough to enable the purchaser to receive and inspect his goods before paying for them. Consequently the panic caught the mills unprepared at a moment when they had outstanding an unusually large quantity of thirty-day accounts. The bottom fell out of the market. Collections almost ceased, and textile manufacturers, especially in New England, were straightened for ready cash. As a result they were forced at once to curtail operations. Mill hands were put on part time and in many cases dismissed, and their decreased purchasing power became in turn another depressing factor in the market. Of all the textile industries, printing suffered most, for this was just the period when the darker winter patterns were being prepared for market. As fashions changed from year to year, such goods, if allowed to accumulate, could not be held over for another season without almost certain loss. In the midst of this uncertainty and trepidation, one of the largest manufacturing groups of New England, the Sprague companies, representing nearly $20,000,000 invested principally in cotton spinning and weaving and printing, though also to some extent in other industries, was forced to suspend. This was the dramatic event in New England industry which marked the beginning of a period of stagnation that was destined to last until almost the end of the decade.[4] In the West, on the other hand, manufacturers were fairly prosperous throughout the year.[5]

It is not our purpose to describe the larger features of the panic, which belong to a history of banking and transportation rather than to a history of manufactures. Suffice it to say that the critical dates were the suspension of a well-known brokerage house, which was heavily involved in industrial and railway bonds, on September 13; the failure of the New York and Oswego Railway on September 17: and that of Jay Cooke the following day. Immediately Fiske and Hatch, another New York financial house, suspended, though they were able to resume a little later. All these em-

[4] *Commercial and Financial Chronicle*, XVII, 583–584, Nov. 1, 1873; *Sen. Doc.* No. 538, 61st Cong., 2d sess., 79–80; *cf. Boston Journal of Commerce*, XXXVIII, 348, Sept. 5, 1891.

[5] *Chicago Inter-Ocean*, Nov. 6, 1873, quoted in American Iron and Steel Association, *Bulletin*, VII, 506, Nov. 26, 1873.

barrassments and insolvencies were precipitated by the tying-up of capital and credit in unproductive railway enterprises, more particularly in the West.[6]

Naturally the stoppage of railway building and railway improvements after a protracted period of intense activity came like a thunderbolt to the iron trade. Prices fell rapidly. Between April 1873 and April 1874, pig iron declined at Pittsburgh from $42 a ton to $28 a ton. Rails fell from $82 a ton to $60 a ton; and this was but the beginning of sagging prices. By the close of the latter year, pig iron had fallen to $24 and rails to $50; and twelve months later considerably more than one-third of the iron furnaces of the country and more than half of the rail mills were wholly idle and the others were running part time. Conditions steadily grew worse instead of better. By the autumn of 1874, 295 of the 677 furnaces in the country were out of blast and the iron trade was in a condition of greater depression than at any time since the beginning of the panic.[7]

These conditions produced the curious anomaly of a highly-developed conservative industry becoming an advocate of inflation. The dependence of the furnace men and rolling mill owners of the United States upon the railways as a market for their product identified their interests with those of the radical frontier. Even "Pig Iron" Kelly, the great champion of protection, for a time espoused greenback theories as a panacea for industrial depression. An article appeared in the official organ of the iron and steel industry condemning President Grant's veto of the inflation bill. Its author asserted that

> "an increased demand for iron and the pacification of labor were expected to follow the adoption of a judicious policy of expansion of the currency"

and as a result of the veto,

> "iron men everywhere, with great unanimity, admit that better days for the iron business and for iron workers are postponed indefinitely."[8]

Two arguments appealed to the protected industrial interests in favor of cheap money: it was expected to enable the railways to continue without interruption the policy of rapid expansion which they had pursued for some years previously, and it would increase the premium on gold, which was an indirect way of raising the tariff wall against importations from specie-currency Europe.

HALTING RECOVERY

While the panic of 1873 was due mainly to domestic conditions, the six years depression which followed was doubtless associated, both as an effect

[6] *Sen. Doc.* No. 538, 61st Cong., 2d sess., 35–37; Wells, *Economic Changes*, 5; *Commercial and Financial Chronicle*, XVII, 382, Sept. 20, 1873; XVII, 857, Dec. 27, 1873.
[7] American Iron and Steel Association, *Report of the Secretary, 1875*, 4–7.
[8] American Iron and Steel Association, *Bulletin*, VIII, 138, Apr. 30, 1874.

and as a cause, with the world-wide stagnation of business which characterized the middle seventies. The Franco-Prussian War destroyed a vast amount of property. Its conclusion was followed by a period of unusually active trade, especially in Great Britain, which country was called upon to furnish, largely upon credit, goods to replace those which had been wasted by hostilities. Many backward countries were inviting development and borrowed large sums of money for this purpose in London, the world's financial capital. A period of over-production ensued, and development work outran the demand for the new resources it made available.[9] The Secretary of State, in his annual report upon our commercial relations with foreign countries during 1876, remarked that for several years the consular communications received by his department had been noticeably uniform "in respect of a decrease of manufactures and commerce, and general apathy in the operations of the other principal branches of business."[10]

Yet with the irrepressible optimism of a young country, our manufacturers and merchants consoled themselves each season with the prediction that the following year would inaugurate a new era of prosperity. Nevertheless trade continued stagnant and, reversing the experience of earlier crises, failures increased both in number in and average liabilities involved after the acute phase of the panic passed.[11] Total liabilities, to be sure, were higher in 1873 than in any subsequent year of the depression prior to 1878, but this was due to the insolvency of a few gigantic firms that did not participate directly in the productive activities of the country. The number of failures more than doubled between 1873 and 1878, which Dun's annual report described as "the fifth year of a depression unparalleled in extent, character and duration."[12]

This was an era of rigid economy, steadily falling prices, minimum profits in almost every field of business and extreme conservatism in granting credit. Throughout the South, except in a few favored districts, the people were still impoverished by their late calamities. A contemporary observer said:

> "Their houses are out of repair; their stock is poorly fed; the men wear homespun clothes a good deal, and the women dress very plainly. There is so little travel on the railroads that it is a mystery how the companies make it pay to run passenger trains. The towns are lonesome and the stores empty of customers."[13]

[9] *Pall Mall Gazette*, quoted in American Iron and Steel Association, *Bulletin*, x, 186–187, July 5 and 12, 1876; National Association of Wool Manufacturers, *Bulletin*, ix, 118–119, Apr. 1879; *Commercial and Financial Chronicle*, xxvii, 212–213, Aug. 31, 1878.

[10] American Iron and Steel Association, *Bulletin*, xi, 133, May 16, 1877; xi, 163, June 13 and 20, 1877.

[11] Dun, Barlow and Company's Annual Report, quoted in American Iron and Steel Association, *Bulletin*, xii, 19, Jan. 23 and 30, 1878.

[12] *Commercial and Financial Chronicle*, xviii, 78, Jan. 24, 1874; xxii, 29, Jan. 8, 1876; xxiv, 3, Jan. 6, 1877; American Iron and Steel Association, *Bulletin*, xiii, 17, Jan. 29, 1879.

[13] American Iron and Steel Association, *Bulletin*, xi, 145, May 30, 1877.

After the panic the country was obliged to meet its debts not by renewals, but by actual payments from its resources. Our exports exceeded our imports by many millions. And what the country was doing on a large scale private firms and individuals were doing on a smaller scale. They were paying as they went, not contracting new debts, but wherever possible clearing off the obligations they still owed.[14]

While 1876 had witnessed a break in the clouds of the depression early in the year, and a return to gloomier conditions later, the situation was reversed in 1877; for after an early season of protracted dullness and hopelessness, a remarkably bountiful harvest, especially in the prairie states, and better prices for grain and provisions than had recently prevailed abroad gave a temporary stimulus to trade. Railroad earnings increased. The demand for public lands was active. More loaded cars were received at Pittsburgh than since 1871, and furnaces and rolling mills were conscious of a reviving demand for their products. To some extent this activity was due to the temporary tonic of a war market in Europe; on the other hand the contested presidential election, the disastrous railway strikes in the summer of 1877, and the agitation of the silver question had been far from reassuring influences.[15]

The situation in 1878 verified the proverb that the darkest hour is just before the dawn. The most numerous failures with the heaviest liabilities in the history of the country were accompanied by an enormous shrinkage of values. A small locomotive works in Pennsylvania which had cost $35,000 or $40,000, sold for $2,500. The Mingo Iron Works made an assignment by which stockholders, whose shares sold at 100 per cent premium in 1873, lost everything.[16] This was recorded as a year of "unparalleled commercial depression . . . as widespread as the world and ubiquitous as trade itself." There were crop failures in Europe and famines in India and China. During this year the bankruptcy law was repealed and business was unsettled by a prolonged debate in Congress on the Silver Bill and other financial measures. One of the worst outbreaks of yellow fever in our history occurred in the South. Prices continued to decline. On the other hand, the November elections resulted in a decisive defeat of the greenback and silver inflation element in politics; and gold fell to par in New York on December 17, 1878, after remaining at a premium since early in January 1862.[17] This cleared the ground for the gradual but consistent revival that began the following year.

RENEWED PROSPERITY

Business failures showed a marked decline both in numbers and total liabilities in 1879. The ratio of insolvency fell from one in every 64 firms

[14] *Commercial and Financial Chronicle*, XXIV, 309–310, Apr. 7, 1877; American Iron and Steel Association, *Bulletin*, XI, 243, Sept. 12, 1877.

[15] American Iron and Steel Association, *Bulletin*, X, 261, Sept. 27, 1876; XI, 251, Sept. 19 and 25, 1877; *Commercial and Financial Chronicle*, XXIV, 3, Jan. 6, 1877; XXVI, 3–4, Jan 5, 1878.

[16] American Iron and Steel Association, *Bulletin*, XII, 165, July 10 and 17, 1878.

[17] *Commercial and Financial Chronicle*, XXVIII, 5, Jan. 4; XXVIII, 161, Feb. 15, 1879.

in 1878 to one in every 105 firms the following year, while the aggregate liabilities of the bankrupt house decreased from $234,000,000 to $98,000,000. In reviewing the business of the year the financial press characterized the recovery as sharp, decided and extended. Specie payment was resumed on January 1. Over half a billion dollars of the public debt was refunded at 4 per cent, mostly at home. Our exports exceeded our imports by $270,000,000. We raised nearly 450,000,000 bushels of wheat, more than 1,500,000,000 bushels of corn, and 5,500,000, bales of cotton. Prices of stocks and of merchandise rose. Railroad earnings improved and a generally buoyant sentiment prevailed in the business world at the end of the year.[18]

The improvement, which was becoming very obvious in the second half of 1879, continued throughout 1880. So many promises of revival had been disappointed during the preceding six years of depression, that the first indications of real prosperity were greeted with some scepticism and apprehension. But the rate of recovery exceeded even the most sanguine expectations, and the requirements of consumers were constantly underestimated. Over-production had come to be accepted as a normal condition of modern industry and business men were unaware of the extent to which the stagnant market had been due to diminished purchasing power. As an American editor wrote:

> "If people waste capital in war as they did in France and Germany; or squander it in bubble schemes, as they did in Germany and Austria; or invest it in railways or other works which cannot be renumerative for years to come, as they did in the United States; or lose it in crop failures as they have recently done all over Europe . . . the income of the world is reduced."[19]

Rigid economies were necessary until old scores were paid off. The period of industrial and commercial convalescence had been a long one, but recovery when it finally came was prompt and vigorous.

In the textile industries, several months fencing between buyers and manufacturers ensued before prices could be fixed on a recognized higher level, but by the autumn of 1880 business was "fully restored." Fully 20 per cent more spindles and looms were in operation than in 1879 and all were promised full employment for many months to come.[20] A brief check reduced the activity of the iron and steel trade during the early summer, and a flurry occurred on the stock exchange. After the fall elections, however, the upward movement of prices became more pronounced, and by the end of the year some securities were quoted higher than ever before in the history of their companies.[21]

[18] *Commercial and Financial Chronicle*, xxx, 28, Jan. 10, 1880; LVI, 4, Jan. 7, 1893.
[19] *Commercial and Financial Chronicle*, xxxii, 170, Feb. 12, 1881.
[20] *Textile Record*, i, 43, Nov. 1880.
[21] *Commercial and Financial Chronicle*, xxxii, 28–29, Jan. 8, 1881.

So at the close of the decade the effects of the panic seven years before had practically disappeared. In 1881 manufacturers were fully employed, frequently with orders ahead for all the goods they could supply until well into the following year. With the restored prosperity of the railroads the demand for iron and steel revived. The excess of exports over imports gradually decreased, partly because we were shipping a smaller quantity of breadstuffs abroad, but partly because the recovered prosperity of the country encouraged the importation of foreign merchandise.[22]

THE INTER-PANIC DEPRESSION

Another reaction, however, ensued in 1883. Failures suddenly increased again. Railroad construction fell off and the iron and steel trade languished. But this depression had none of the features of a panic. It was rather the normal let-up after the precipitate recovery of the years immediately preceding.[23] This period of comparative stagnation continued throughout the following year, although signs of improvement, especially in the retail trade, were evident in the autumn of 1884. Pittsburgh, however, was far from prosperous. It was estimated that there were in the city, 3,000 empty tenements which had been vacated by laborers who had removed elsewhere in quest of employment. Wheeling was similarly affected.[24] Many cotton mills in the South suspended operations after filling their warehouses with unsold goods. It was reported that nearly one-third of the 24,000 members of the trade unions of Cincinnati were idle.[25] The financial situation was described as a "quiet panic."[26] Yet it was generally recognized that the center of the depression was in the iron industry and that this condition in turn was due to a halt in railway construction. Between 1879 and 1883 we built more than 40,000 miles of road. The price of rails which was over $70 in 1880 fell to $33 a ton in 1883. There was a decrease of nearly 1,000,000 tons in our output of pig iron in 1884 and a corresponding decline occurred in other metallurgical industries.[27]

Prices continued to sag during the ensuing year. In December 1885, cotton touched 5 pence per pound at Liverpool, the lowest price in thirty years. Wheat averaged less in 1884 and 1885 than any previous two years of the century. Bar silver fell to well under 4 shillings per ounce, thus reducing the purchasing power of India and China and other Asiatic markets for cotton fabrics.[28] This was a period of marked depression in Great Britain.[29]

[22] *Commercial and Financial Chronicle*, xxxiv, 8, Jan. 7, 1882.
[23] *Commercial and Financial Chronicle*, xxxviii, 7–8, Jan. 5, 1884.
[24] American Iron and Steel Association, *Bulletin*, xvii, 347, Dec. 19–26, 1883; xviii, 237, Sept. 17, 1884.
[25] American Iron and Steel Association, *Bulletin*, xviii, 245, Sept. 24, 1884; *cf.*, however, *Manufacturers' Record*, vi, 519, Dec. 6, 1884.
[26] American Iron and Steel Association, *Bulletin*, xviii, 259, Oct. 8, 1884.
[27] American Iron and Steel Association, *Bulletin*, xviii, 259–260, Oct. 8, 1884; xviii, 317, Dec. 3 and 10, 1884; *Commercial and Financial Chronicle*, xl, 8–9, Jan. 3, 1885.
[28] *Commercial and Financial Chronicle*, xli, 706–707, Dec. 19, 1885.
[29] *Commercial and Financial Chronicle*, xl, 139–140, Jan. 31, 1885; xlii, 110, Jan. 23, 1886; National Association of Wool Manufacturers, *Bulletin*, xix, 35–37, Jan. 1889.

Yet the first intimations of better times were already beginning to appear. Stocks of merchandise were getting low. Railways, which had economized during the preceding seasons, were forced to undertake repairs and some new construction. Although foreclosures and receiverships increased early in the year, good crops and expanding traffic, as well as a better understanding among competing roads and the cessation of rate wars, promised more stable conditions in the future for the transportation industries. Money had accumulated at our financial centers in unwonted quantities. Gradually the feeling became general that the dawn of a new period of activity was at hand.[30]

During 1886 recovery was slow but fairly steady, although business was livelier in the early months of the year than after March, when a series of labor disturbances began which unsettled manufacturing until the middle of the summer.[31] Railway building was actively resumed. Wages were in several instances increased. A short stock exchange panic in Wall Street late in December did not interrupt this gradual revival. A more serious check to recovery occurred the following year, when a severe drought was experienced throughout the grain regions of the West. Notwithstanding this, however, the country added nearly 13,000 miles to its railway system, the price of steel rails advanced, railway earnings rose and the iron and steel industries were active.[32]

TARIFF REDUCTIONS

A downward revision of the tariff was in prospect, since the Democrats had control of both Houses of Congress and the Presidency. While the Mills Bill was under discussion, manufacturers hesitated. Some reaction occurred in the iron and steel industries, as was natural after the unusual railway extensions of the year before. Pig iron and steel rail prices declined, though not as rapidly as during previous periods of curtailed railway development, and production still exceeded that of any previous year except 1887. The steel market was toned up by the growing use of this material for structural and general industrial purposes. Cotton manufacturers were prosperous and there was an unusually active demand for prints. On the other hand, wool manufacturers suffered from the tariff agitation. The presidential election passed without serious disturbance to business; several large trusts were organized; and over 16,000,000 acres of public lands were acquired by settlers. Our imports were very large and the trade balance was heavily against us, so that gold began to move to Europe.[33]

[30] American Iron and Steel Association, *Bulletin*, XIX, 209, Aug. 12, 1885; *Commercial and Financial Chronicle*, XLII, 37–38, Jan. 9, 1886.

[31] *Boston Commercial Bulletin*, quoted in American Iron and Steel Association, *Bulletin*, XX, 185, July 21, 1886.

[32] American Iron and Steel Association, *Bulletin*, XXI, 229, Aug. 24, 1887; XXI, 293, Oct. 19, 1887; *Commercial and Financial Chronicle*, XLVI, 8–9, Jan. 7, 1888; XLVI, 151, Feb. 4, 1888.

[33] *Commercial and Financial Chronicle*, XLVIII, 10–12, Jan. 5, 1889.

During 1889, cotton manufacturing continued prosperous, but the woolen business was seriously depressed, and failures among woolen dealers and wool manufacturers involved liabilities exceeding $10,000,000, or three times the amount of the preceding year. This was partly due to speculation in raw materials, but also to the effect of the new tariff in unsettling confidence. Yet the iron trades, which also might be supposed to feel the results of the new law, were unexpectedly prosperous, even though railway construction fell off. Our corn and oats crops were the largest ever raised, although prices were far from satisfactory. Upon the whole, 1889 was a satisfactory business year.[34]

THE BARING FAILURE

The outstanding financial fact of 1890 was the Baring failure in London, with all that implied as registering the culmination of a period of excessive and ill-judged investments in new countries, unwise speculative undertakings, and the beginning of a world-wide financial stringency which was to reach a climax in the United States three years later. An attempt by a French syndicate to organize a world monopoly of copper failed. British capitalists had invested enormous sums in railway and mining enterprises in the British colonies and South America, particularly the Argentine. In both Great Britain and Germany there had been much speculation in industrial stocks—some of which were of precarious value. The same banking houses that were backing these uncertain enterprises were also furnishing money to various undertakings in America. For example the Barings were heavily interested in the Santa Fe Railroad, the Sugar Trust, and probably in American coppers.

The effect of this crisis in Great Britain was immediately felt in the United States, where it became more difficult to finance new enterprises. Capital suddenly ceased to flow to our country from Europe. More than this, large quantities of American securities held abroad were thrown upon the American market. Our crops were not as abundant as usual and we had less than the normal quantity of wheat, oats and corn to export. The price of cotton was low. New railway mileage naturally declined and this was immediately reflected in a weaker demand for iron and steel. While our cotton mills were busy, their profits were less than usual. On the other hand, wool manufacturers had recovered somewhat from the depression of the previous year.[35]

Both the opening and the closing years of the decade ending with 1890 witnessed land booms in the South and West. Population was shifting rapidly. New cities were springing up in hitherto sparsely populated sections and real estate speculation became a craze. This led to considerable

[34] *Commercial and Financial Chronicle*, L, 10–12, Jan. 4, 1890.

[35] American Iron and Steel Association, *Bulletin*, XXIV, 332, Nov. 19, 1890; *Commercial and Financial Chronicle*, LII, 9–11, Jan. 3, 1891.

unproductive investment of capital, especially in the South, where boom values of real estate were more apt to be based upon the prospect of future industrial development than they were in the agricultural West. A number of iron furnaces were erected about this time at points which later experience showed to be ill-chosen. In the same way that the town promoter often anticipated the urban needs of a locality by several generations, so the industrial promoter sometimes anticipated the market growth of the country for many years ahead.[36]

Yet in spite of the Baring failure, the diminished inflow of new capital from Europe, and the tendency to reverse the former balance of trade to our disadvantage, business continued fairly prosperous throughout 1891. The currency situation had not begun to cause anxiety, although our gold exports became noticeable soon after the silver purchase law of 1890 was enacted. Cotton and wool manufacturing were fairly prosperous and our textile output continued to grow larger. The iron and steel trades suffered from curtailed demand and there was a marked decline of output during the first half of the year. Cotton growers felt the effect of low prices, caused partly by large crops two years in succession and partly by the lessened purchasing power and stagnant markets of the silver standard countries. Raw wool was likewise unusually abundant, there being a decided increase in the clip of both South America and Australasia.[37]

PRE-PANIC CONDITIONS

The enactment of the McKinley Tariff encouraged American manufacturers, although it produced a crisis in the wool industry in some parts of Europe and added to the depression in Great Britain.[38] Toward the close of the year it was observed that stocks of certain raw materials and manufactures were beginning to accumulate. Gold exports continued and prevented a revival of business confidence even where other conditions seemed temporarily favorable. We were beginning to suffer the penalty for—

> laying out towns where there is nothing to support them, building blast furnaces where there is neither iron nor coal nor a market, constructing railroads which are not needed, and booming sparsely settled sections far in advance of the wants of our present population."[39]

Upon the whole the year was one of general reaction from the "bounding activity of 1890," of a reaction which was not confined to our own country but was world-wide. Bank accommodations, even to meet current business needs, became difficult to obtain. The abundant crops in 1891 and an unusual European demand for them did not materially alleviate the situa-

[36] *Cf.* Bruce, *Rise of the New South*, 211; American Iron and Steel Association, *Bulletin*, XXII, 53, Feb. 15, 1888; XXV, 349, Nov. 25, 1891.
[37] *Commercial and Financial Chronicle*, LIV, 59, Jan. 9, 1892.
[38] *Commercial and Financial Chronicle*, LIV, 187, Jan. 30, 1892.
[39] American Iron and Steel Association, *Bulletin*, XXVI, 60, Mar. 2, 1892.

tion. Western farmers felt the benefit, and railway revenues rose; but the effect was largely local. Land booms were collapsing, and our exports were paid for with European manufactures, or by Europe's return of our own securities. Indeed, so many of the latter came back to our shores, partly on account of the financial stringency abroad, and partly because European investors distrusted our ambiguous currency policy and feared that by some unsuspected juggling they might be forced to accept silver in payment for their obligations, that we continued to export increasing quantities of gold. As a natural consequence, the security market was heavy and the banking situation was far from reassuring.[40]

In spite of these unpromising auspices, business was fairly satisfactory during 1892. Cotton, after sagging for several months, suddenly took an upward turn and the market for cloth was active and mills were well employed. Wool manufacturers had a reasonably prosperous year. More iron was made during the first half of 1892 than ever before in a period of equal length; and the demand was sustained in no small part by heavy consumption in the building and machine trades. Our imports continued to increase, exceeding those of any previous year in spite of the high duties levied by the McKinley Tariff. Failures were not excessive and the liabilities were less than two-thirds those of the previous year.

On the other hand, the silver agitation continued to have a disturbing effect on the business situation. Our crops of both grain and cotton fell far below those of the two exceptionally good seasons which had preceded. These conditions were reflected in railroad earnings, exports and rates of foreign exchange. The latter ruled so high as to encourage gold exports until well into the autumn, when our produce shipments were normally at their height; but they did not prevent large importations of foreign merchandise. Money was fairly easy and in spite of the Presidential election and of several serious labor conflicts, manufacturing was active.[41]

THE PANIC OF 1893

This protracted strain, especially upon the country's currency and credit, reached the breaking point in 1893, which witnessed one of the worst business crises in our history. It was not accompanied by some of the disturbing conditions—and especially by the shock to public credit—that were such serious features of our earlier panics. Business recovered more rapidly than after 1873. But our industries were by this time gigantic compared with those of even 20 years before. A shut-down of mills and factories caused relatively greater unemployment. The free public land cushion, which had hitherto received the main impact of the blow which such a crisis represented to the welfare of the working population, was becoming very thin. It was not so easy as formerly to shift from the factory to the farm.

[40] American Iron and Steel Association, *Bulletin*, XXVI, 132, May 11, 1892.
[41] *Commercial and Financial Chronicle*, LVI, 11–13, Jan. 7, 1893.

This crisis began early in May, when there were several serious failures in Wall Street, and the Cordage Trust, one of the new giant corporations with which the country was just beginning to be familiar, "collapsed like a bursted meteor," a catastrophe that shook confidence in all of the new industrials.[42] Immediately manufacturing plants began to shut down or to curtail operations and to turn many of their employes adrift. No market existed for their products and they could not get ready money to pay their hands. Throughout the summer this was the universal complaint. The Reading Iron Company was reported to have disbursed a ton and a half of silver to its employes on a single pay day, no other currency being available. In some towns—for example, New Castle, Delaware—every mill and factory was shut down, and 50,000 textile workers were idle in Philadelphia. The destitution in Pittsburgh was said to be "unprecedented." Late in the year, Bradstreets estimated on the basis of reports from 119 industrial cities that more than 800,000 wage earners were in idleness within their vicinity, representing, with their dependents, a population of nearly 2,000,000. This did not include the large army of unemployed in small manufacturing towns and villages and in the mining and lumbering districts.[43]

So far as the panic was accentuated by the lack of currency, relief began to appear before the year was well advanced. Government bonds fell to so low a point that it became profitable for banks to issue notes against them. Gold began to be imported and clearing house certificates were generally employed. During the last two months of the year it was estimated that the currency medium of the country was increased by about $129,000,000 from these three sources. The Silver Purchase Bill was repealed and by New Year, 1894, it was generally felt that the worst of the currency crisis proper was over. Manufacturers, after an epidemic of closing-down in July and August, began to resume. Failures did not increase remarkably and the World's Fair at Chicago distracted the attention of the country to some extent from its immediate difficulties.[44] Moreover the effect of the panic was not felt with equal severity in all parts of the country. The South, which had gone through a process of radical liquidation the year before, had entered 1893 better prepared to meet the new attack on its prosperity and suffered relatively less for that reason.[45]

[42] *Commercial and Financial Chronicle*, LVI, 728, May 6, 1893; American Iron and Steel Association, *Bulletin*, XXVII, 141, May 10, 1893.

[43] American Iron and Steel Association, *Bulletin*, XXVII, 173, June 7, 1893; XXVII, 205, July 5 and 12, 1893; XXVII, 237, Aug. 9, 1893; XXVII, 245, Aug. 16, 1893; XXVII, 293, Oct. 4, 1893; XXVIII, 4, Jan. 1, 1894.

[44] American Iron and Steel Association, *Bulletin*, XXVII, 241, Aug. 16, 1893; *Commercial and Financial Chronicle*, LVIII, 9–10, Jan. 6, 1894.

[45] *Cf. Manufacturers' Record*, XXIII, 362, June 16, 1893; XXIII, 416, July 7, 1893; XXIII, 463, July 28, 1893; XXIV, 371, Dec. 29, 1893.

CHAPTER XV

GENERAL ASPECTS OF INDUSTRIAL LIFE

Speculative Aspects of American Industry, 167. Currency and Prices, 168 Manufacturing Profits, 171. Exports of Manufactures, 172. Industrial Organization, 174. Trust Litigation and Legislation, 176. Labor and Wages, 177.

SPECULATIVE ASPECTS OF AMERICAN INDUSTRY

An attempt to ascertain and analyze the causes of the fluctuating prosperity of manufactures between 1873 and 1893 would lead us into a highly controversial field. It has been observed that the alternations of prosperity and depression in the United States were usually more marked than those abroad. As a contemporary writer said—"Compared with Great Britain . . . we always seem to rise to greater heights and fall to lower depths." Contrasting the depression in cotton spinning in the two countries in the early eighties, the consumption of raw cotton in the northern states declined 6.4 per cent in 1883–1884 and 13.7 per cent the following year, going back to its figure five years previously. While Great Britain likewise experienced a set-back in its cotton trade, the decrease in the two years mentioned was respectively only 2.5 and 3.4 per cent.[1]

American business men were accused of greater readiness than those of Great Britain and Europe to embark their business capital in speculative enterprises outside their legitimate fields. This custom, for which there was an exceptional temptation in a new country offering alluring prizes to business adventurers, had existed ever since we had manufactures worthy of record. Many of the New England mill owners who failed in the crisis of 1837 owed their insolvency to speculating in public lands. Several iron masters failed in the panic of 1857, because they had been too eager to pledge their resources and credit upon large deliveries made to railways for which they took in payment the highly speculative securities of the latter. The same unwise practice, of embarking funds required for the use of an established business in riskier adventures elsewhere, continued during the period we are now discussing.[2]

About 1890—in fact, very shortly before the Baring failure—British investors began to buy and consolidate American firms in several lines of business. English syndicates were reported to be purchasing about this time boiler and locomotive plants, elevator lines, cotton duck mills, the Elgin Watch Company, a large group of St. Louis flour mills, the leading

[1] *Commercial and Financial Chronicle*, XLI, 293, Sept. 12, 1885.

[2] *Commercial and Financial Chronicle*, XVIII, 1, Jan. 3, 1874; *cf.* American Iron and Steel Association, *Bulletin*, XXXI, 90, Apr. 20, 1897, for a summary of the unique speculative features of this period.

New England tanneries, a series of Kentucky distilleries, paper mills in northern New York and other enterprises of the most varied character. To be sure, it was rumored that part of this capital was fictitious, and that the English purchasers were in some cases promoters who operated on the theory that they could unload the inflated stocks and bonds of their new corporations upon the American public. Baring Brothers and Company were rumored to be largely interested in American investments of this character. The failure of that firm put a sudden stop to English syndicate movements, and possibly contributed in this way to puncture the inflated values given industrial stocks and securities by the speculative activities of the period.[3]

CURRENCY AND PRICES

Two problems of an economic character mainly occupied the attention of the American business world—the tariff and the currency. Our per capita circulation increased from about $18 to about $24 during the 20 years ending with 1893. It was at the latter date materially larger than that of Great Britain, Germany, or other industrial countries with large accumulations of domestic capital. The resumption of specie payment in 1879 and the Silver Purchase Act for the coinage of standard silver dollars were substantially coincident. The latter law did not drive gold out of the country, because the Government maintained an artificial parity between the two metals; but the relative increase of silver dollars was very large, almost equaling the increase of gold in circulation.[4]

The prominence of the currency question, upon which almost everybody took definite sides, encouraged economic writers to find in our monetary laws and practices an explanation for most of the business phenomena of the period; and this assumption in turn was met by the theories of another school of thinkers who were inclined to go to the other extreme in minimizing the influence of currency upon our economic life. Protectionists were disposed to attribute depression to faults in the tariff, currency reformers to defects in our monetary system.

In order to understand the unusual interest in such questions during these two decades and the forms that interest took, we must bear in mind that throughout the world this was a period of almost constantly falling prices for both raw materials and manufactured goods. In 1876 woolen and cotton fabrics were sold at lower rates than at any previous time within the memory of men engaged in the trade. Wages had declined and some articles of food like flour were reasonably cheap, but upon the whole the price of provisions was well maintained. Since 1873 most of the commodities quoted in the London market had fallen from 10 to 30 per cent in

[3] American Iron and Steel Association, *Bulletin*, XXIII, 341, Dec. 11, 1889; XXIV, 2, Jan. 1 and 8, 1890; XXIV, 10, Jan. 15, 1890; XXIV, 213, July 23, 1890; XXIV, 341, Nov. 26, 1890.

[4] *Commercial and Financial Chronicle*, XLVII, 186, Aug. 18, 1888; XLVIII, 171, Feb. 9, 1889; American Iron and Steel Association, *Bulletin*, XXVII, 211, July 19, 1893

value. In 1883 the necessities of life could be bought in the mill towns of Pennsylvania at prices which seem incredible today.[5]

In a newspaper debate involving different views regarding the tariff, figures were quoted to show that a group of 50 manufactured articles ordinarily consumed on an American farm including textiles, machinery, lumber, sheeting, sugar, flour, soap, starch, oil and canned goods, which would have cost more than $678 in 1873, could be purchased for $276 fourteen years later—a decline of nearly 60 per cent. Between 1860 and 1888 identical brands of cotton shirtings, sheetings and drills had fallen in price from 30 to 40 per cent. Print cloths, bleached sheetings and finer fabrics had declined fully one-half.[6]

An elaborate comparison of retail prices in 1880 and 1890 indicated that the average reduction in the case of farm implements, hardware, groceries, textiles and lumber had been from one-fourth to one-half during the decade. In 1885 the very best white oak and ash, such as was used in making vehicles, machinery and furniture, sold for $20 a thousand in Kentucky, and building oak could be bought for $14. In 1891, it was observed that there had never been a time in the history of the country when manufactured goods could be purchased so cheaply as that year. Boots and shoes, woolen goods and cotton fabrics were quoted lower than ever before. In fact this phenomenon was world-wide.[7] It was the desire to stem this steady reduction in prices, among other things, that encouraged the formation of industrial trusts, so many of which were organized at this period.

Hitherto business crises in Great Britain and America had been interpreted chiefly as money panics. Economic speculations engaged the attention of bankers and men familiar with financial affairs before they aroused equally vigorous interest among the manufacturing classes. This helps to explain, perhaps, why so much stress was laid in early economic writings upon the part played by monetary conditions in determining eras of commercial and manufacturing activity or stagnation. In 1873, however, American currency, although inflated, was reasonably sound, our banking system was in a fairly healthy condition, and the causes which had been so prominent upon the surface in earlier panics either did not exist or were not thrust upon public attention. The steady fall of prices throughout the world, and particularly in America, was the great dominant condition which faced business men. It stimulated—indeed, it made necessary—economies in production. The decline was not confined to manufactures, but was, in fact, felt even more keenly by farmers and planters. Consequently men began to hear more about overproduction than ever before. The world, it was argued, was raising more food than its people

[5] American Iron and Steel Association, *Bulletin*, x, 81, Mar. 15, 1876; xviii, 11, Jan. 9, 1884; *Commercial and Financial Chronicle*, xviii, 463, Nov. 11, 1876.

[6] American Iron and Steel Association, *Bulletin*, xxi, 34, Feb. 9, 1887; xxiii, 26, Jan. 30, 1889.

[7] American Iron and Steel Association, *Bulletin*, xxiv, 132–133, May 14, 1890; xxv, 177, June 17, 1891; xxvi, 107, Apr. 20, 1892; National Association of Wool Manufacturers, *Bulletin* xxi, 354–355, Dec. 1891; xxiii, 204–205, Sept. 1893.

could consume and producing more cotton, wool and other textile fibers than manufacturers could find markets for; and as a result there was always a surplus. Even a small surplus, as history showed, might depress prices disastrously. Railways had been built through the Argentine and had been extended in Australia. Both regions had become within a comparatively recent period large producers of grain and provisions as well as of wool and hides. India suddenly entered the world market as an important wheat exporting country. To be sure the population of Europe, which was the great consuming center for this surplus, was growing rapidly, but, many argued, not rapidly enough to absorb the extra production. If this excess had begun to manifest itself in the case of provisions and raw materials, how much more marked it was likely to be in the case of manufactured articles, where improved processes and machinery were multiplying output. So what may be called the overproduction explanation for commercial and industrial depression suddenly came into vogue.[8]

It is not necessary to accept either of these explanations in their entirety, nor would it be profitable here to delve deeply into the problem with which they are concerned. The explanations themselves, however, are of some significance. They are a product of the period and like all such products tell us something of their source. These 20 years witnessed the largest opening of virgin territory and virgin resources of any equal period in our history. They saw the most rapid application of modern machinery and the most fruitful adoption of scientific methods of agriculture that had occurred in human experience. The completion of the Suez Canal and of our own trans-continental railroads had revolutionized the routes of world commerce. The introduction of the Bessemer and open-hearth processes for making steel made possible almost unlimited plant expansion. These were years pre-eminently of exploiting new regions in the temperate zones—much as the middle decades of the present century may prove to be the great era of development in the torrid zone. Our own country, especially, found itself meeting growing competition from other countries possessing resources similar to its own.

Upon the whole, also, these were 20 years of peace. Wealth was not wasted by great European wars. As goods and commodities became more abundant, it naturally was easier to procure them, but the existence of this constant surplus—or threatened surplus—often reduced profits to a minimum, encouraged mass production in order to lower costs, and created a motive for arbitrarily limiting output. These ends it was sought to gain by new forms of industrial organization, and through law-made privileges.

On the other hand, men who considered currency conditions the major factor in determining price movements and business prosperity or depression had this justification for their opinion: Our credit system and our

[8] *Commercial and Financial Chronicle*, XLVI, 790, June 23, 1888; *cf.* however *id.*, XLV, 839–840, Dec. 24, 1887; XLVI, 58–60, Jan. 14, 1888.

currency laws were not suitable for a country which had reached the stage of business evolution we had then attained. Our forms of credit were changing, but all too slowly, from those of a planting nation to those of a modern industrial state. A growing proportion of our business transactions were on a spot-cash or 30 day credit basis. The old crop-to-crop advances played a relatively minor part in the business life of the country. In other words, we were using more money and turning over the money we used more rapidly than before. The need of an elastic currency was therefore increasingly felt and a more flexible credit system was sorely needed.

MANUFACTURING PROFITS

Periods of declining prices are normally periods of low profits and curtailed operations in manufacturing. Customers restrict their purchases in hope of still lower prices, and refuse to make long-time contracts. They keep factory owners constantly on the *qui vive* for a market, and they endeavor to throw all the speculative risks of the whole chain of commercial operations between the purchase of raw material and the sale of products to the consumer upon the shoulders of the factory owner.

No data exist for a generalization as to the fluctuation of manufacturing profits during the 20 years we are here describing. It is possible, of course, to follow the dividend payments of individual establishments, and with a larger element of error those of special industries in particular sections of the country. But it often happened that some companies prospered while their competitors were losing money. In a year when raw materials were falling, while manufactured products temporarily held to their former price level or declined but moderately, a mill or corporation that purchased its supplies late in the season might show a profit, while a forehanded company that had contracted for its materials earlier would show no profit or a loss. On the other hand, when prices of both raw materials and manufactured goods were rising, the situation of the two companies might be reversed.

After the panic of 1873, the New England cotton manufacturing corporations, whose dividends were declared at Boston, almost without exception reduced their payments to their stockholders. Several passed their dividends in 1874; but even that year at least one company paid 10 per cent.[9] In 1876 occasional resumptions or increases of dividends are recorded and the Chicopee Company more than doubled its capital by a stock dividend, although the general record of manufacturing corporations was reported to be "one of the poorest for many years."[10] From the panic to the end of the decade, the list of companies passing dividends at the date of quarterly and semi-annual statements was regularly a long one.

Ten years later, in 1890, the Massachusetts Bureau of Labor Statistics issued a report on the profits of manufacturing industries in the Common-

[9] *Commercial and Financial Chronicle*, XVII, 804, Dec. 13, 1873; XVIII, 14, Jan. 3, 1874; *cf.* however, *id.*, XIX, 15, July 4, 1874.

[10] *Commercial and Financial Chronicle*, XXIII, 15, July 1, 1876.

wealth, which covered more than 23,000 establishments, representing a capital of over $500,000,000 and producing annually nearly $700,000,000 worth of goods. After making allowance for depreciation and interest on borrowed capital, the average profits of these establishments appeared to be under 5 per cent; and of these industries, cotton manufacturing was among the least remunerative.[11] Yet the average annual dividends of the 34 mills at Fall River between 1883 and 1893 were nearly 8 per cent.[12]

Very large profits were frequently made by individual establishments. A comparison of reported dividends would suggest that these were higher as a rule in the case of smaller and isolated mills than of large corporations located at great industrial centers. We must bear in mind, however, that exceptional profits or losses were more likely to be reported by smaller or remoter establishments, while the dividends of the large companies were published regularly from quarter to quarter and year to year. In 1881, for instance, one of the two woolen mills in California paid a dividend of 30 per cent and the other paid 18 per cent.[13] Ten years later the Graniteville mills in South Carolina made a net profit of 17 per cent upon their capital.[14] A small factory in Georgia earned over 30 per cent and profits of from 10 to 15 per cent were not uncommon. During the panic of 1893 the largest cotton mills in Georgia continued to pay 6 per cent to their share-holders.[15]

EXPORTS OF MANUFACTURES

In 1874 the United States exported domestic manufactures to the value of $107,000,000. Ten years later that sum had risen to $155,000,000, and in 1894 to $202,000,000. This was very moderate growth indeed compared with the progress made immediately thereafter.[16] In fact foreign markets at this time had a negligible influence upon the industrial prosperity of the country, an influence probably no greater in proportion to the total volume of our manufactures than it had been 50 years before.[17]

During the period of curtailed domestic consumption that followed the panic of 1873, the possibility that mills and factories might be kept running on orders from abroad received some consideration. Locomotives, patented machinery for working leather and making shoes, and above all, agricultural implements and sewing machines were already being sold to overseas consumers; and the example of these industries attracted attention to similar opportunities for others.[18] Indeed the period of dull trade and low prices

[11] Summarized in *Commercial and Financial Chronicle*, LIII, 237–239, Aug. 22, 1891.
[12] *American Wool and Cotton Reporter*, XIII, 1234, Oct. 19, 1899.
[13] Hittell, *Commerce and Industries of the Pacific Coast*, 435.
[14] *Manufacturers' Record*, XXI, 31, Apr. 29, 1892.
[15] *Manufacturers' Record*, XXI, 33, May 6, 1892; XXIV, 366, Dec. 29, 1893.
[16] American Iron and Steel Association, *Bulletin*, XXXIX, 26, Feb. 15, 1905; Department of Commerce and Labor, *Statistical Record of the Progress of the U. S. 1800–1907*, p. 17.
[17] National Association of Wool Manufacturers, *Bulletin*, VII, 323–324, Oct. 1877.
[18] American Iron and Steel Association, *Bulletin*, VII, 245, Apr. 2, 1873.

in the middle seventies made many American business men feel that we were—

"almost able to compete successfully in the markets of the world for outside consumption, and thus to obtain quicker relief for our languishing industries than by waiting for the slow growth in home consumption to overtake our producing power."[19]

We did ship some cotton goods to England. American merchants and factors established themselves in London for the express purpose of handling the foreign trade in American merchandise. One such firm sold American goods to the value of about $1,000,000 a year. These included plows, reapers, mowers, lawn mowers, smaller agricultural implements, garden tools, wooden ware, furniture, ice-cream freezers, churns, sewing machines, clocks, axes, pumps and excavating machinery. The London catalogue of the British branch of another American firm covered 59 closely printed folio pages, devoted almost entirely to tools and hardware. The market for American tools and machinery in Germany and Denmark was also growing. Both the Waltham and the Elgin companies had selling houses in London and the latter had an agency in St. Petersburg. American organs were widely introduced abroad, and Fairbanks scales were familiar to British merchants.[20]

About the time of the Centennial Exhibition, foreign trade promotion was taken seriously in hand by a few enterprising business men. In 1877 some 30 American cotton manufacturing companies and several makers of stoves, nails, shovels and hardware united to send a large shipment of sample goods to Italy, to be exhibited to the chambers of commerce and other commercial bodies of that country.[21] We were again shipping coarse cottons to China and India, thus reviving a branch of trade which had been extinguished temporarily by the Civil War. American drugs were finding a market abroad. Even tool steel was sent from Pittsburgh to England on regular orders, and American glassware was shipped to Liverpool in considerable quantities.[22] The British colonies afforded a market for American iron and steel manufactures ranging all the way from cookstoves to locomotives.[23] In 1879 a permanent exhibition of American manufactures was projected at Rio de Janeiro.[24] By the early eighties, our general trade with China was increasing both in volume and variety. That country had begun to purchase not only cotton but also flour, clocks, chemicals,

[19] *Commercial and Financial Chronicle*, XXI, 523–524, Dec. 4, 1875.
[20] American Iron and Steel Association, *Bulletin*, IX, 298–299, Oct. 8, 1875.
[21] American Iron and Steel Association, *Bulletin*, XI, 69, Mar. 7, 1877.
[22] American Iron and Steel Association, *Bulletin*, X, 241, Sept. 13, 1876; XI, 97, Apr. 11, 1877; XI, 114, Apr. 25, 1877.
[23] London *Colliery Guardian*, June 22, 1877, quoted in American Iron and Steel Association, *Bulletin*, XI, 193, July 18 and 25, 1877; National Association of Wool Manufacturers, *Bulletin*, VI, 304, Oct. 1876.
[24] *Boston Commercial Bulletin*, quoted in American Iron and Steel Association, *Bulletin*, XIII, 147, June 11, 1879.

glassware, firearms, lamps, petroleum, manufactured tobacco and clothing. During the year ending with June 1880, we shipped 11,290,411 bolts of cotton goods to that market.[25]

Nevertheless, although these exports contributed toward turning the balance of trade in our favor, they never approached our imports of manufactured goods. In 1893 we purchased abroad manufactures to the value of $364,000,000 and shipped similar goods to foreign customers to the value of $179,000,000. It was not until 1898 that we began to export more manufactures than we imported.[26]

INDUSTRIAL ORGANIZATION

No marked change occurred in the forms of industrial organization after the panic of 1873. To be sure the Standard Oil Company dates from the early seventies, but its methods at first were not new and it found no immediate imitators.[27] During these years several new manufacturers' associations were organized, partly with the object of establishing uniform prices and rates of wages in certain industries. They were most common in the iron trade.[28] A few hopeful, but relatively minor, experiments with co-operation date from this period. In 1874 the first co-operative cooper shop was started at Minneapolis. Eventually eight such shops were organized, and they controlled a major part of the barrel manufacturing business of this flourishing flour metropolis.[29] A co-operative foundry went into operation at Troy before 1870 and apparently prospered for a time.[30]

The really significant development in the field of industrial organization during these twenty years was the appearance of the trusts, during the middle and late eighties and the early nineties, when prices fell below all previous low levels and consequently margins between costs of production and the amount received for staple manufactures were reduced to a minimum. This was a time, likewise, when production was growing faster than consumption, even though consumption was rapidly expanding. A contemporary writer intimately familar with big industry thus explained the origin of these organizations:

> "It is worth while to inquire into the appearance and growth of trusts and learn what environments produce them. Their genesis is as follows: A demand exists for a certain article beyond the capacity of existing works to supply it. Prices are high and profits tempting. Every manufacturer of that article immediately proceeds to enlarge his works and increase their producing power. In addition to this, the unusual profits attract the attention of his principal

[25] *Textile Record*, II, 98, Apr. 1881.

[26] American Iron and Steel Association, *Bulletin*, XII, 165, July 10 and 17, 1878; XXXIII, 147, Sept. 1, 1899; Department of Commerce and Labor, *Statistical Record of the Progress of the U. S. 1800–1907*, 15, 17.

[27] *Commercial and Financial Chronicle*, XV, 208–209, Aug. 17, 1872.

[28] *Cf.* Bogart and Thompson, *The Industrial State*, 402.

[29] *Christian Union*, quoted in American Iron and Steel Association, *Bulletin*, XIX, 274, Oct. 14, 1885.

[30] *Hunt's Merchants' Magazine*, LXII, 121–122, Feb. 1870; *cf. History of Co-operation in the United States*, Johns Hopkins University Studies, 157, 1888.

managers or those who are interested to a greater or less degree in the factory. These communicate the knowledge of the prosperity of the works to others. New partnerships are formed and new works are erected, and before long the demand for the article is fully satisfied and prices do not advance. In a short time the supply becomes greater than the demand and there are a few tons or yards more in the market for sale than are required, and prices begin to fall. They continue falling, until the article is sold at cost to the less-favorably situated or less-ably managed factory, and even until the best managed and best equipped factory is not able to produce the article at the price at which it may be sold.

"Political economy says that here the trouble will end. Goods will not be produced at less than cost. This was true when Adam Smith wrote, but it is not quite true today. When an article was produced by a small manufacturer, employing, probably at his own home, two or three journeymen and an apprentice or two, it was an easy matter for him to limit or even to stop production. As manufacturing is carried on today, in enormous establishments with five or ten millions of dollars of capital invested and with thousands of workers, it costs the manufacturer much less to run at a loss per ton or per yard than to check his production. Stoppage would be serious indeed.

"The condition of cheap manufacture is running full. Twenty sources of expense are fixed charges, many of which stoppage would only increase. Therefore, the article is produced for months and, in some cases that I have known, for years, not only without profit or without interest on capital, but to the impairment of the capital invested. Manufacturers have balanced their books year after year only to find their capital reduced at each successive balance. While continuing to produce may be costly, the manufacturer knows too well that stoppage would be ruin. His brother manufacturers are, of course, in the same situation. They see the savings of many years, as well, perhaps, as the capital they have succeeded in borrowing, becoming less and less, with no hope of a change in the situation. It is in soil thus prepared that anything promising relief is gladly welcomed. The manufacturers are in the position of patients that have tried in vain every doctor of the regular school for years, and are now liable to become the victum of any quack that appears. Combinations, syndicates, trusts—they are willing to try anything. A meeting is called, and in the presence of immediate danger they decide to take united action and form a trust. Each factory is rated as worth a certain amount. Officers are chosen, and through these the entire product of the article in question is to be distributed to the public at remunerative prices. Such is the genesis of 'trusts' in manufactured articles."[31]

We can distinguish three distinct forms of industrial grouping, each of which falls within the popular conception of a trust. The legal definition we shall leave for later consideration. These three forms are: (1) Aggregations of local industries, illustrated by the combinations of breweries in particular cities promoted and partly financed by British capital, by the unions of brick yards in several towns, and by an amalgamation of sash and door mills at Chicago. These combinations were designed to control prices and conditions of production in a strictly local market. (2) Aggregations of different processes, such as iron and coal mines, railways, steamship lines, furnaces, steel works, and rolling mills and other re-manufacturing plants. Industries thus grouped into what are now known as

[31] Andrew Carnegie, in the *North American Review*, CXLVIII, 141–142, Feb. 1889.

vertical trusts might aim to control the market, but they sought primarily to stabilize and economize processes of production. (3) Aggregations within a larger industry such as the Glassware Trust, separate from the Window-glass Trust and the Plateglass Trust; or the Wallpaper Trust, the Straw-board Trust, and the Writing Paper and Print Paper Associations in the larger paper industry; or the combinations of manufacturers of steel tubing, steel hoops, tin plate and other specialized products in the iron and steel industry.

TRUST LITIGATION AND LEGISLATION

The trust question became a political and legal issue in America during the middle eighties and centered first around the operations of the Sugar Trust, which was attacked in the courts. This trust was a combination among leading refiners to restrict production, which had been excessive. Its first purpose was doubtless protective, not so much to extort unfair prices as to stop destructive competition. But having discovered the secret of market control, its possessors were tempted to abuse their power. Moreover, their method of preventing a market overstock was public and conspicuous. When there was too much sugar, some of the refineries in the combination were shut down. At the same time, however, independent firms were encouraged to embark in the business by the apparently assured stability of prices and guaranteed profits due to trust control. When the first Sugar Trust was formed, it refined about 90 per cent of the sugar in the United States. Within a few years, this proportion had been reduced to 75 per cent. This trust was attacked in the courts and a series of decisions against it, obtained in the New York Supreme Court in 1889, was expected "to put a stop to all such combinations." And yet it was foreseen even then that this trust might "undergo a metamorphosis and escape the decision's effect."[32]

Legislative investigations were also started. In February 1888, the House Committee on Manufactures introduced a resolution for an investigation by its members into combinations of this character, and in the autumn of that year Senator Sherman introduced the bill which was to become eventually the first Federal act dealing with them. A year later a Senate Committee of the New York Legislature inquired into the same subject and presented majority and minority reports.[33] The following year the status of trust certificates upon the New York Stock Exchange became a matter of some concern to the business world. Among the large combinations whose certificates were dealt in among the unlisted securities were the Lead Trust, with $83,000,000 capital, the Cotton Oil Trust and the Sugar Trust, each with something over half that capitalization, the Distillers' and

[32] United States Industrial Commission, *Report*, I, 48, 109; American Iron and Steel Association, *Bulletin*, XXI, 301, Oct. 26, 1887; XXII, 33, Feb. 1, 1888; XXIII, 219, Aug. 14, 1889; XXIII, 313, Nov. 20, 1889; *Commercial and Financial Chronicle*, XLIX, 52, July 13, 1889.

[33] American Iron and Steel Association, *Bulletin*, XXIII, 138, May 22 and 29, 1889.

Cattle Feeders' Trust, and the American Cattle Trust.[34] This does not exhaust the list of such corporations. Some twenty large companies or trusts had been organized at this time or were formed immediately afterward, several of which were dissolved for business reasons or else reorganized during the following decade. Few of them paid large dividends and the investors in several suffered heavy losses. It was not exceptional for these new combinations to return the constituent companies to their original stockholders. The Wallpaper Trust, for instance, did this. It was discovered that in this business a proprietor's management was more economical and efficient than management by trust agents. Experience proved that the owner could interpret and supply the wants of the several communities served as no central management could do. The United States Flour Company came to the conclusion that it could save a considerable sum by leasing to their former owners its constituent establishments, instead of trying to operate them as one property. So the pioneer period of trust organization was by no means as promising as the promoters of these enterprises hoped; nor did these amalgamations succeed in extorting from the public in all instances the excessive prices feared.[35]

LABOR AND WAGES

Unemployment and wage reductions naturally accompanied the crisis of 1873 and the ensuing depression; but two conditions helped to mitigate their effect. Immigration declined rapidly after the panic; and though a smaller proportion of the immigrants of the seventies were industrial workers than would be the case today, since our public lands still attracted farmers from Europe, the lessened inflow of foreign wage-earners helped to lighten the labor market.[36] In the second place, many workingmen who had been well employed at liberal wages during the recent boom, had saved enough to establish themselves in the New West. In 1878 Dun and Company noted in their annual report that with the shutting down of blast furnaces and other large employing establishments the sales of public lands about doubled.[37] It was observed that the ore miners of the Lake Superior region drifted away to farms whenever the iron trades were depressed. The coming in of foreigners, who settled oftentimes in sections of American manufacturing towns where native workmen and workmen of English and Scotch descent were living previously, disposed the latter to sell their homes and to remove to other localities, generally the West.[38]

These twenty years saw the rise and decline of industrial unionism as represented by the Knights of Labor, and the supplanting of the latter organization by the American Federation of Labor, an alliance of unions

[34] *Commercial and Financial Chronicle*, XLIX, 52, July 13, 1889.
[35] *Commercial and Financial Chronicle*, LXXI, 991–993, Nov. 17, 1900.
[36] *Cf.* American Iron and Steel Association, *Bulletin*, X, 10, Jan. 12, 1876; X, 53, Feb. 16, 1876.
[37] Brassey, *Work and Wages*, 229.
[38] *Cleveland Trade Review*, quoted in American Iron and Steel Association, *Bulletin*, XVII, 122, May 9, 1883.

representing different trades instead of different industries. Many strikes occurred, especially in metal working, mining and the railway service. The principle of collective bargaining and a sliding scale by which wages were proportioned to the price of products had become well established in agreements between iron puddlers and their employers. In fact it was mainly in the iron trades, and especially among the puddlers, that labor was well enough organized during the earlier years of this period to enforce its demands with fair success; for the workingmen in these trades possessed more solidarity than their employers. In 1877 Pittsburgh manufacturers gave, among their reasons for granting the demands of their puddlers for higher wages, the fact that western competitors took advantage of Pittsburgh strikes to keep in operation and extend their markets, under an agreement with their workmen that any increase of wages at Pittsburgh would, as soon as accepted by employers there, be introduced at the western mills.[39]

Several employers' associations were formed about this time, primarily to resist the Knights of Labor. In 1886 the textile manufacturers of Massachusetts were reported to have entered into an agreement to adopt a common policy in case of strikes. The same year the textile manufacturers of Philadelphia and the brass manufacturers of the country organized for the same purpose.[40]

Although factory laws were to be found on the statute books of many states, and had in some cases been in force for several decades, the employment of young children, and indeed of all workers, for excessive hours, was much more common than today. In 1886 it was asserted that children only six years old were working in the cotton mills of Augusta, Georgia. The New Jersey inspector of factories and workshops found 15,000 young children employed in the 5,000 factories of the state. The average age at which they went to work was nine years, and they were employed from 10 to 14 hours a day. Their weekly wages did not exceed as a rule $2. At Cohoes, New York, children, sometimes not yet in their teens, were kept at work in the cotton mills under harsh overseers for 11 hours a day. Corporal punishment was used to discipline these child workers, whose wages often went to support idle fathers, who could find no employment in competition with the cheaper labor of their own children.[41]

More stress than hitherto was laid on the scientific background of industry. The Cambria Iron Company established a "Scientific Institute," where its employes might learn modern languages, elementary science, mechanical drawing and engineering.[42] The first technical school in the southern states was established at Atlanta, Georgia, in 1886.[43] Textile

[39] American Iron and Steel Association, *Bulletin*, XI, 179, July 4, 1877.

[40] American Iron and Steel Association, *Bulletin*, XX, 109, Apr. 28, 1886; XX, 125, May 12, 1886; XX, 132, May 19–26, 1886.

[41] American Iron and Steel Association, *Bulletin*, XVII, 298, Oct. 24–31, 1883; XIX, 163, June 24, 1885; XX, 149, June 9, 1886.

[42] American Iron and Steel Association, *Bulletin*, XVII, 306, Nov. 7, 1883.

[43] American Iron and Steel Association, *Bulltin*, XX, 299, Nov. 17, 1886.

schools were opened at Lowell and Philadelphia.[44] A growing recognition of the importance of technical education was also reflected in the establishment during this period of four engineering societies, the American Society of Civil Engineers, the American Institute of Mining Engineers, the American Society of Mechanical Engineers, and the American Institute of Electrical Engineers.[45]

Although wages were reduced in most localities and in nearly all industries after the panic of 1873, they probably remained higher than they were before the Civil War. During the middle seventies it was a popular amusement with statisticians to compare the current pay of mechanical and factory workers with the rates prevailing 15 or 20 years before. These comparisons gave such inconsistent or contradictory results, however, as to justify doubt of their accuracy. According to one account, between 1860 and 1876 the wages of brick layers remained stationary at about $2 a day, while those of stone cutters and masons approximately doubled.[46] Figures prepared by the Baltimore and Ohio Railroad in 1877 showed that after the reduction in wages made that year the pay of train crews was not far from what it had been in 1861.[47] Freight conductors and brakemen were receiving a little more at the latter period, while engineers and firemen were receiving less. In 1882, one of the most competent authorities in the country estimated that average wages had risen between 1860 and 1878, but that real wages had declined during the four years following the latter date. Between 1878 and 1882 the nominal pay of workmen rose about 7 per cent, but prices advanced 21 per cent.[48] According to another estimate the average annual wages of mechanics had advanced from $468 in 1860, to $720 in 1886, and their purchasing power had increased even more than these figures indicated. Real wages of skilled labor were supposed to have nearly doubled, and those of unskilled labor to have risen by one-half during the quarter century preceding.[49]

A marked improvement in wages occurred during the later eighties, accompanied by some shortening of the working day. At Pittsburgh pay increases amounting in some instances to 50 per cent occurred between 1886 and 1890, accompanied in most cases by a reduction in hours.[50] Labor was, of course, more liberally remunerated in the United States than abroad. According to a comparison between the earnings of knitting mill hands working for the same employer in Great Britian and at Lowell, made

[44] *Cf.* National Association of Wool Manufacturers, *Bulletin*, XXI, 293–294, No. III, July 1891; Clarke, *Education in the Industrial and Fine Arts in the United States*, United States Bureau of Education, *Reports, 1898*, passim.

[45] American Iron and Steel Association, *Bulletin*, XXVII, 73, Mar. 8, 1893.

[46] American Iron and Steel Association, *Bulletin*, X, 237, Sept. 6, 1876.

[47] *Commercial and Financial Chronicle*, XXV, 107, Aug. 4, 1877.

[48] Carroll D. Wright, in *Princeton Review*, July 1882, quoted in American Iron and Steel Association, *Bulletin*, XVI, 181, July 3, 1882.

[49] American Iron and Steel Association, *Bulletin*, XXI, 5, Jan. 5 and 12, 1887; *cf. id.*, XIII, 13, Jan. 15 and 22, 1879.

[50] *Pittsburgh Commercial Gazette*, quoted in American Iron and Steel Association, *Bulletin*, XXIV, Dec. 3, 1890.

in 1885, wages in the latter city were about 45 per cent higher than in England.[51] In 1883 a comparison of weekly wages of employes in identical occupations in the factories of the Clark Thread Company at Newark, New Jersey, and at Paisley, Scotland, showed that the American employes were receiving from two to three times the nominal compensation paid abroad. Wages in the latter country ranged from a minimum of $2.50 to a maximum of $7 a week; in the Newark establishment they ranged from a minimum of $5.50 to a maximum of $20 a week.[52]

[51] *Boston Journal of Commerce*, 110, vol. 27, Dec. 26, 1885.
[52] Quoted from the *New York Tribune*, in American Iron and Steel Association, *Bulletin*, XVII, 35, Feb. 7, 1883.

CHAPTER XVI

GEOGRAPHY OF MANUFACTURING

CAUSES INFLUENCING THE LOCALIZATION OF MANUFACTURES

No new influence made itself felt during these two decades, in determining the localization of manufactures as between city and country and between different manufacturing districts, comparable with that exercised by railways during the first half of the century; but the forces first manifested at an earlier period continued to operate and their effect became more obvious as the importance of our manufacturing industries increased.

Naturally some shifting occurred in the geography of primary manufactures, such as the production of lumber and certain metals, in response to the changing sources of their raw materials. Industrial specialization as between locality and locality continued to increase. Some cities, hitherto possessing a variety of industries of approximately equal importance, became distinguished for the production of a single line of goods. We have already mentioned the concentration of fine cotton spinning and weaving, and of cotton printing at Fall River; and of the curious centralization of brass manufacturing in the Naugatuck Valley. We might add to these the increasing relative importance of Philadelphia as a seat of carpet weaving, of the Mohawk Valley as a knit goods center, and of Milwaukee and Philadelphia as tanning cities.[1]

In this age of large establishments, the more or less arbitrary location of a single immense factory at a point where there had been previously no concentration of industries tended to attract other enterprises of the same kind, or smaller works auxiliary to the principal factory. Such auxiliary establishments either served the requirements or consumed the by-products of the main establishment. It was natural for dye works to spring up in a cloth manufacturing town. When Buffalo proved a favorable point for the distillation of wood alcohol, this gave encouragement to the location of charcoal-iron furnaces in the same vicinity. A factory town where one sex is predominantly employed attracts manufactures which will give work to the opposite sex. This explains in part the movement of silk mills to the older metal working centers of eastern Pennsylvania.

After a group of allied industries is well established at any point, it requires a very considerable shock to dislocate it from that position. Usu-

[1] Several other interesting examples of this tendency are mentioned in New England Cotton Manufacturers' Association, *Proceedings, October 30, 1889*, 37–38.

ally a population of skilled operatives has become domiciled in the vicinity, and transportation lines and trade channels have accommodated themselves to supplying materials for workers in these industries, and to distributing the products of their labor.[2]

A change which had begun before the Civil War and continued to characterize the distribution of manufacturing during this period was the growing proportion of the total manufactured product of the country which was made in the South and West. This did not represent so much a geographical decentralization of industries as the rise of new manufacturing districts in parts of the country where they had not hitherto existed or had been of little importance. In 1850 nearly four-fifths of our manufacturing industries, measured by gross value of product, were situated in the states bordering upon the Atlantic, and, of course, in large part north of the Potomac. This proportion had declined to 58 per cent in 1890. To some extent, perhaps, these figures are subject to correction; because at the earlier date manufacturing returns were relatively less complete in the newer sections of the country, and household and small shop manufacturing unreported in the census still played an important part in the nation's industrial economy.

The steady movement of the geographical center of manufacturing toward the West and South did not involve any decline in manufacturing or lessening of its density in the New England and Eastern states. It was accompanied, indeed by a growing concentration of certain branches of industry in those regions, and by an increasing division of labor in secondary production between different parts of the country, such as already began to be noticeable in the sixth and seventh decades of the century.

Statistics showing this movement are qualified by the fact that the value of raw materials formed a larger fraction of the gross value of manufactures produced in the West and South than of those produced in the East. The same condition applied to comparisons of the total and the per capita value of manufactured products produced in large cities and in smaller towns. Meat packing is a conspicuous instance of an industry in which the gross value of product is disproportionately large compared with the value added to raw materials by labor and machinery, and this is a business which contributed not a little to the purely statistical drift of manufactures toward the West and toward the large cities.

In a broad way the tendency was for the manufacture of a growing share of railway supplies and equipment of agricultural machinery and farm implements, of building and construction materials, of wood manufactures, especially furniture, and of foods and drinks, to concentrate in the West. On the other hand the textile industries were little affected, if at all, by this movement. They required the aids of many adjuncts which were not easily obtained remote from the seaboard: imported dyes and chemicals,

[2] *Cf.* Webber, *The Growth of Cities*, 199–209; Schulze-Gavernitz, *The Cotton Trade*, 82.

the prompt arrival of new patterns from Europe, foreign wool and silk and long staple cotton, and the advantage of greater proximity to the textile centers of the old world. The East had a large fixed population of skilled workers and received the first pick of the trained operatives who arrived from Europe. The cost of transporting cotton, wool and silk, and of distributing the fabrics made from them was a comparatively small element in the cost of finished goods to the consumer.[3]

NEW ENGLAND INDUSTRIES

In this particular branch of industry, New England continued to lead its rivals. In 1880 that section produced half of the woolen goods and four-fifths of the cotton fabrics, as well as three-quarters of the boots and shoes, made in the United States. Massachusetts made most of the fine paper produced in the country, and Maine was until well toward the close of the period one of our principal sources of wood pulp. Boston was reputed to rank next to New York and Philadelphia as the third city in the United States in the value of manufactured goods produced within its limits.[4] Nor was this precedence disputed during the remainder of the century. In 1897 the English statistician, Mulhall, in a review of the manufacturing progress of the United States, called attention to the fact that the value of the annual output of the factories of New England had multiplied fivefold during the 40 years between 1850 and 1890. At the time he wrote no European country could vie with New England in respect to manufactures. Its annual output—principally in goods to which labor and machinery added a large fraction of their final worth—was $319 per capita as compared with $115 in Great Britain, $88 in Belgium and $74 in France. But it was in the rate of progress that the growing importance of that section in the world's industry was most conspicuous. During the 40 years just mentioned, the per capita value of manufactured goods produced annually in Great Britain remained about stationary, rising, according to this statistician's figures, from $111 to $115; while during the same period the corresponding figures in New England were $104 and $319. Equally notable was the increase in the number of operatives and likewise in their rate of wages during these years. The average earnings per operative in the New England states were estimated to have been $246 at the middle of the century and $469 in 1890.[5]

No significant change occurred during these years in the distribution of industries within the New England states, other than minor migrations which will be described in connection with the particular branch of manufacture which they affected. As early as 1877 the governor of Maine called attention to the fact that saw mills, which until recently had represented

[3] *Cf. Textile Record,* I, 44, Nov. 1880.
[4] *Boston Commercial Bulletin,* quoted in American Iron and Steel Association, *Bulletin,* XV, 89, Apr. 13, 1881.
[5] *North American Review,* CLXIV, 569–571, May 1897.

the largest manufacturing industry of the state, had declined in relative importance until their output was surpassed in value by that of cotton factories. Iron works, boot and shoe factories, tanneries, woolen mills and flour mills each outranked in value of product her shipyards, which prior to the Civil War were regarded as another of Maine's leading industries. Even at this date the factory products of Maine, manufactured by steam or water power, were valued at nearly $80,000,000 annually, or more than double the total production of her farms.[6]

Massachusetts regularly led New England in the value of its industrial products. Factories accounted for about 91 per cent of the total wealth annually created in the state, including the products of agriculture, fishing and commerce. It is suggestive of the character of these industries that in 1887 the freight on raw materials and finished goods averaged but 3 per cent of the value of output.[7]

CENTRAL ATLANTIC AND GREAT LAKE STATES

Although New England thus maintained its historical position as the point of greatest manufacturing concentration in the Union, New York uniformly ranked first among the states in both the gross and the net value of its manufactures. Massachusetts, which was second in 1850, fell to third place in 1860, and to fourth place in gross value, but not in net value of manufactured product, 30 years later. Pennsylvania held second place in each of these items after 1860. Illinois usurped the rank of Massachusetts as the third state in the gross value of manufactured products in 1890.

Although Philadelphia ranked behind New York in the value of its manufactures, it claimed to be the seat of more varied and distinctive industries than any other city in the Union.[8] It was our greatest single textile manufacturing center, producing in 1890 some $22,000,000 worth of woolen fabrics, $22,000,000 worth of carpets, $15,000,000 worth of knit goods, $15,000,000 worth of worsteds, and $8,000,000 worth of silks.[9] New York City in 1880, when it included only Manhattan Island, manufactured goods exceeding in value by more than $30,000,000 all the imported merchandise that crossed its wharves.[10]

When the Granger Movement was at its height in 1875, the fact that this agitation was more violent in Illinois than in Ohio was attributed to the relatively greater development of manufacturing in the latter state.[11] Throughout the West, however, manufacturing was already more influential than commerce in promoting urban growth.[12] The mere marketing

[6] Maine, *Journal of the House of Representatives*, 1877, 291–292.

[7] *Commercial and Financial Chronicle*, L, 851–853, June 21, 1890.

[8] American Iron and Steel Association, *Bulletin*, X, 164, 180, June 7 and June 28, 1876; *Textile Record*, II, 238, Sept. 1881.

[9] Eleventh Census, Report on Manufactures, *Statistics of Cities*, 436–453.

[10] American Iron and Steel Association, *Bulletin*, XVI, 154, June 7, 1882.

[11] *New York Tribune*, quoted in American Iron and Steel Association, *Bulletin*, IX, 81, Mar. 26, 1875.

[12] *Cf.* Bogart and Thompson, *The Industrial State*, 400–401; American Iron and Steel Association, *Bulletin*, XIII, 173, July 9, 1879.

of goods did not engage a large population. It was the making of things that called people to the city from the country and produced great urban centers. Indianapolis, the metropolis of what was then regarded as an agricultural state, had a population in the middle seventies of about 100,000 and its factories and workshops were reported to employ at that time 10,000 skilled artisans. The city manufactured iron products of all kinds, vehicles, agricultural implements, furniture, starch, clothing, oil and some cotton and woolen fabrics. Terre Haute had an "Association for the Promotion of Manufactures," and had become a center of more than local importance for the production of engines and machinery. No important town of the state was destitute of some factory or works.[13] The same was true of Detroit, which already was an important center for the manufacture of iron and steel products and machinery. Detroit stoves had a country-wide reputation. Grand Rapids had become by 1873 a well-known furniture making center.[14] Of course Chicago was already the greatest manufacturing city of the West, and her steel works, harvester works, car shops, packing houses, clothing factories and other important industries bulked large in the productive mechanism of the country. To be sure, several of these industries were dispersed in many small establishments. For example, in 1879, Chicago had within its municipal limits 343 woodworking shops or factories important enough to be recorded in the census, besides 246 iron foundries and machine shops, 156 other metal works, and 111 breweries and distilleries. Altogether, 2,271 industrial establishments were enumerated in the city, with a yearly output valued at nearly $268,000,000.[15]

Typical of the early establishment of manufactures close to the frontier wherever cheap power and transportation were available is the early prominence of Minneapolis as an industrial town. "The platform over St. Anthony's Falls" was reported in 1877 to be "the most profitable manufacturing locality in the world." It already was the site of 16 flour mills, a woolen mill, a cotton mill, and iron works, a railroad machine shop, a paper mill, a carding mill, a sash and door factory, 2 planing mills and 8 saw mills.[16]

During the twenty years ending with 1890, Illinois passed Ohio as the leading state in the manufacture of agricultural machinery. Indeed, in this industry Ohio showed a decrease of output between 1880 and 1890. Massachusetts held its own as the largest producer of boots and shoes, although Pennsylvania ranked first in tanning. Massachusetts likewise led in the manufacture of paper, cotton goods and woolen fabrics, except

[13] American Iron and Steel Association, *Bulletin,* VIII, 332, Nov. 5, 1874.
[14] American Iron and Steel Association, *Bulletin,* VIII, 332, Nov. 5, 1874; IX, 197, July 2, 1875.
[15] American Iron and Steel Association, *Bulletin,* VIII, 332–333, Nov. 5, 1874; *Western Manufacturer,* Jan. 15, 1879, quoted in *id.,* XIII, 28, Feb. 5, 1879.
[16] American Iron and Steel Association, *Bulletin,* XII, 1, Jan. 2 and 9, 1878; *cf. id.,* IX, 67, Mar. 12, 1875.

carpets and worsteds. Pennsylvania made more carpets, Rhode Island more worsteds and New Jersey more silk goods, than any other state.[17]

MANUFACTURING IN THE SOUTH

In 1890 the states north of Maryland and the Ohio River, and east of the Rocky Mountains, produced about 85 per cent of the country's manufacturing output, while the states south of that line, including Delaware, Maryland, West Virginia, Kentucky, Arkansas, Oklahoma and Texas, produced only a little more than 10 per cent.[18] Nevertheless the growth of manufacturing in the South during this period was very significant both in the productive economy and in the social and political history of the nation. Four or five groups of industries in that section represented the utilization of new natural resources, or the accommodation of manufacturing to new and more economical conditions of production. This applied particularly to the growth of the iron, the lumber, the cotton, the cottonseed oil and the fertilizer manufactures. The development of the mineral and fuel resources of the Chattanooga-Birmingham district was one of the most important events in the country's metallurgical annals during this period. Southern foundry irons, as we shall see, supplied a market reaching even to the North Atlantic seaboard and the Great Lakes, and for a time the South was the point of cheapest pig-iron production in the United States. Iron-working centers in that section determined the location of railway lines, the sites of important cities, and the grouping of a large industrial population not directly engaged in mining and furnace occupations.

Lumbering was by no means a new industry in the South. In fact the Carolinas were important sources of lumber supply even before the colonies became independent; and during the first half of the century commercial lumbering on a comparatively large scale had begun in the Southern pine belt. But the real exploitation of the forest wealth of that region waited for obvious reasons upon the partial exhaustion of the sources of supply immediately tributary to the Great Lakes and to rivers accessible to Northern markets. The great wealth of hard-wood timber in the South was protected by its inaccessibility until railways penetrated the Southern Appalachian highlands. It chanced that railways built to tap new mineral resources were also favorably located for handling the furniture and joinery woods of the latter region. Equally isolated hitherto had been the great areas of swamp land which were the home of the southern cypress. These likewise were tapped when the southern railway net began to embrace the less easily developed but immensely fertile bottom lands of the coastal and flooded river districts, and to stretch out tentacles to a number of new and ambitious seaports.

The old theory that the cotton mill would come to the cotton fields saw the first substantial promise of realization during this period, notwithstanding

[17] Eleventh Census, *Report on Manufactures*, I, Table 5.
[18] Eleventh Census, *Report on Manufactures*, I, 9.

New England's continued supremacy as the nation's great textile manufacturing center. Before 1893 the existence of conditions in the South that give this region an economic advantage in the production of certain fabrics had been practically demonstrated. An industrial interest and an operative population had grown up in what had been previously predominantly planting sections; and cotton mills did more to revolutionize the social standards and perhaps the real political creed of the South than any other single branch of industry.

Cottonseed oil, which had been made in a small way for 50 years or more, rapidly became a southern product of very great importance. It was virtually a newly discovered natural resource, or a by-product formerly worthless, which suddenly was found to be highly valuable. The erection of cottonseed-oil mills at almost every important railway center of the cotton-raising states added to planters' profits and to the general wealth and well-being of the community where they were established, even though these mills employed a relatively small operative population. The same is true of the fertilizer industry, which was not unrelated to the manufacture of cottonseed oil, but owed its exceptional growth to the discovery of phosphate deposits in the South Atlantic states. This branch of manufacture was also directly associated with improvements in southern agriculture, and thus accelerated the accumulation of local wealth and capital, which was an important preliminary condition for the growth of general manufacturing.

Partly because 1879 was a census year, the South's industrial revival after the Civil War is often referred back to that date.[19] Of course it is misleading to set any hard and fast chronological boundary to a historic economic process of this kind. In 1876, Columbus, Georgia, congratulated itself upon having restored completely the iron works and cotton mills destroyed by Northern forces twelve years before; and all through Georgia a spirit of industrial enterprise was stirring. The rolling mills of that state and Tennessee were running double-time and with orders ahead, in spite of the serious set-back to railway building caused by the panic three years before. Five new cotton mills were being built in Georgia, of which the largest, at Atlanta, was to contain 20,000 spindles. In the autumn of that year not a single cotton mill in Georgia was idle, and the minimum dividends paid by any establishment were 10 per cent.[20] By 1880 the movement toward manufacturing had gained full headway and in all of the former slave states new mills were being built and old ones were being enlarged. They were mostly for the manufacture of cotton and considerable Northern capital was enlisted in these enterprises. Where until after the Civil War one little river in North Carolina "rolled on uninterrupted through a beautiful valley, its music falling only on the ears of the honest

[19] *E.g.*, *Baltimore Journal of Commerce*, quoted in *Industrial South*, VI, 380, Sept. 1886.
[20] American Iron and Steel Association, *Bulletin*, X, 245, Sept. 13, 1876; X, 277, Oct. 18, 1876.

farmer," in 1880 its waters turned the wheels of six cotton factories within a distance of seven miles. A tendency was noted to diversify manufactures. Small establishments to produce a multiplicity of articles for local use were springing up in all directions. It was estimated that during 1884 over $100,000,000 of new capital was invested in manufacturing south of the Ohio.[21]

During the five years that followed 1880, if we may trust contemporary estimates, the number of cotton spindles in the South more than doubled, the number of cottonseed oil mills increased from 40 to 146, the quantity of pig iron produced rose from less than 400,000 tons to more than 700,000 tons.[22] The value of the cotton crop, while increasing rapidly, formed only one-third of the South's agricultural yield, and of the total production of this region 40 per cent now consisted of manufactures as compared with 32 per cent six years before.[23] Flour was the largest single item of the South's manufacturing output, and lumber ranked second in importance; but in both cases the value of raw materials constituted a large fraction of the value of the finished article.[24]

An interesting illustration of southern manufacturing progress is afforded by industrial statistics gathered for the city of Richmond at intervals since before the Civil War. During the quarter of a century between 1858 and 1883, the value of agricultural implements made in that city practically trebled and the value of boots and shoes quadrupled. A fertilizer industry with an output exceeding $1,000,000 a year had grown up from nothing; iron-works had doubled the value of their output and paper mills had quadrupled their product. On the other hand, the value of the flour and meal ground in Richmond fell from nearly $5,000,000 to less than $3,000,000 and the value of manufactured tobacco rose only from $6,250,000 to $8,000,000.[25]

Industrial expansion continued at a rapid rate from 1885 to 1890 and culminated in a boom at the opening of the following decade, which collapsed just prior to the panic of 1893. Each of these years witnessed the opening of new factories in all parts of the South. Not only furnaces, spinning mills and cottonseed-oil mills, but also furniture factories, vehicle factories, canneries and miscellaneous establishments contributed to the record of new enterprises. In 1888 the new establishments numbered 3,618 and the following year 5,135. The additional capital invested annually in manufacturing now exceeded $200,000,000. Even during the panic year of 1893, some 2,300 new factories of sufficient importance to be

[21] *Textile Record*, II, 72, Mar. 1881; II, 231, Aug. 1881; *Manufacturers' Record*, VI, 263, Oct. 11, 263, 1884; VI, 680, Jan. 10, 1885; *cf.* however, *id.*, VII, Feb. 21, 1885.

[22] *Baltimore Journal of Commerce*, quoted in *Industrial South*, VI, 380, Sept. 1886.

[23] *New Orleans Times Democrat*, quoted in *Commercial and Financial Chronicle*, XLIII, 285, Sept. 11, 1886.

[24] Hillyard, *The New South*, 184.

[25] *Hunt's Merchants' Magazine*, XXXVIII, 115–117, Jan. 1858; *Virginia, A Geographical and Political Summary* (Richmond, 1876), 115; *A Historical and Descriptive Review of the Industries of Richmond* (Richmond, 1884), 42–43.

noted were established in that region. These included more than 50 cottonseed-oil mills and well toward 100 cotton mills.[26]

This growth was due to an abundance of raw materials, cheap labor and cheap power. The steady decline in the price of cotton diverted some capital from planting to manufacturing. While spinning mills and furniture factories used white labor, thousands of negroes working at low wages performed the heavy tasks around the blast furnaces, coke ovens, rolling mills, oil mills and saw mills of this section. A few attempts were made to employ colored labor even in cotton mills but never with permanent success.[27] Practically all the operatives were native whites, although at first farmers' families refused to come into the mills for fear of the social stigma attaching to that employment. It was related that at one cotton factory in South Carolina, erected in a district where there was a surplus farming population, it was necessary at first to import white girls from Baltimore to "break the ice." When the young people of the neighborhood saw these workers spending more money on dress and luxuries than they were able to spend, they overcame the prejudices of their parents and sought employment in the new establishment, so that soon the labor supply was greater than could be used. More money circulated, the standard of living rose, and the market for diversified local manufactures increased. In fact, even at this date, the mountain farmers were largely self-subsisting, and homespun garments were in many districts the common form of clothing.[28]

Some re-distribution of population naturally occurred with the establishment of factories in what had previously been exclusively agricultural sections. Small towns sprang up where only farms had been and cities took the place of former villages. Roanoke, Virginia, grew from a way-station with a few families to a town of 3,000 people within a year after the erection of iron works, wood-working establishments and a cotton mill at that point.[29] The population of the old town of Danville, in the same state, increased from less than 3,500 in 1870 to 13,000 15 years later. At the latter date there were 3 furniture factories, 2 cotton mills, and 26 tobacco factories at this point. Throughout the Shenandoah Valley similar though less marked changes were occurring. It was recorded in 1885, that within eighteen months nearly 100 new mills and factories had been erected along the line of the Cape Fear and Yadkin Valley Railroad in North Carolina.[30]

In fact some parts of North Carolina were already highly industrialized although the greater part of the state remained exclusively agricultural.

[26] *Manufacturers' Record*, XIV, 13, Jan. 5, 1889; XXXVI, 379, Dec. 28, 1899; XXIV, 368, Dec. 29, 1893.

[27] Bruce, *Rise of the New South*, 157, 174, 185, 187.

[28] American Iron and Steel Association, *Bulletin*, XXI, 186, July 13, 1887.

[29] American Iron and Steel Association, *Bulletin*, XVI, 275, Oct. 11, 1882; *Industrial South*, VI, 51, Feb. 4, 1886.

[30] *Industrial South*, VI, 115, Mar. 11, 1886; VI, 283, June 24, 1886; VI, 297, July 8, 1886.

Most of its factories and mills were of moderate size, but they made a wide variety of products. They drew their raw materials almost entirely from local sources, instead of importing them as did the maturer industries of the North. Cotton and cottonseed-oil mills, grist mills, saw mills, furniture factories, turpentine distilleries and tobacco factories were typical of this class of establishments. They were owned and conducted, in nearly every instance, by citizens of the state.[31]

South Carolina differed from her sister commonwealth in the relatively greater importance of cotton manufacturing, as compared with other factory industries within her borders, and in the larger size of her textile establishments. While her total manufactured product in 1890 was only three-fourths that of her northern neighbor, she produced more cotton goods in her 34 factories that the latter did in her 91 smaller mills.[32]

If we except Texas, whose huge size and primary industries placed her in a class by herself, Georgia in 1890 ranked first among the cotton states in value of manufactured product. Her cotton mills contained more looms and spindles than any other state south of the Potomac; and Atlanta, Augusta, Macon, and Columbus were thriving industrial towns.[33] Alabama's most significant contribution to the manufacturing progress of the South was made by her iron furnaces and saw mills; yet cotton spinning was also a growing and prosperous business, even though all the spindles in the state in 1890 would hardly equip a first-class New England factory.

Measured by value of manufactured product Maryland and Kentucky ranked first and second respectively among the states classed by the eleventh census in the southern group. But both belonged industrially to the North. Kentucky's distilleries and breweries and Maryland's canneries were respectively the largest and the second largest contributors to their manufacturing output. Baltimore and Louisville were the leading industrial cities south of Mason and Dixon's line and the Ohio River. Lexington, Kentucky, which early in the century had been one of the first manufacturing towns west of the Alleghenies, no longer had factories of importance although it was tributary to the largest hemp growing area in the United States, to abundant supplies of wool, tobacco, timber and iron, and to one of the richest agricultural regions in the country.[34] With the rise of power-using manufactures, Louisville, situated directly on the great coal highway afforded by the Ohio River, had easily supplanted her.[35]

Tennessee had acquired a respectable position among the iron-producing states through the development of this industry in the vicinity of Chat-

[31] Hillyard, *The New South*, 139; Bruce, *Rise of the New South*, 187.

[32] Eleventh Census, *Report on Manufactures*, I, Table 6.

[33] American Iron and Steel Association, *Bulletin*, X, 297, Nov. 8 and 15, 1876; XVI, 10, Jan. 11, 1882; *Textile Record*, II, 307, Nov. 1881; *Manufacturers' Record*, VI, 136, Sept. 3, 1884; VII, 136, Mar. 14, 1885; VII, 23, Apr. 4, 1885; *Boston Journal of Commerce*, Oct. 17 and Nov. 28, 1885.

[34] *Cf.* Kentucky Bureau of Agriculture, Horticulture, and Statistics, *Sixth Annual Report*, 317.

[35] *Cf. Manufacturers' Record*, VIII, 826, Jan. 30, 1886.

tanooga.[36] Knoxville had a number of textile mills. Nashville was a flour-making center of some importance and also manufactured furniture from the hard woods of the adjacent territory. Memphis was the home of a variety of industries, including clothing shops, flour mills, cooperage factories, cotton mills, saw mills, and particularly cottonseed-oil mills.[37]

[36] Hillyard, *The New South*, 400.
[37] Memphis Merchants' Exchange, *Reports, 1884, 16–23, 1885, 60–65, 1886, 54–69*, passim

CHAPTER XVII

IRON MINES AND THE ORE TRADE

ORE SOURCES AND PRICES

At the end of 1874, our blast furnaces were estimated to have a capacity of about 4,500,000 tons of pig iron per year, and to require some 10,000,000 tons of ore a year to keep them in constant operation. Much of this ore was transported relatively long distances, either by land or by water. The Lake Superior and Missouri mines at this time furnished a very large proportion of the ores used west of the Alleghenies, and Lake Superior ores were shipped in considerable quantities to western New York and even to eastern Pennsylvania. Lake Champlain ores were not only used in the blast furnaces but were the chief material employed as a puddling fix east of the Alleghenies. The eastern Pennsylvania furnaces received their supplies from their immediate vicinity and from New Jersey. Most of the southern furnaces obtained their ore from neighborhood sources. In general American ore hauls were much longer than those of Great Britain and Europe, and the cost of transporting raw materials was an appreciably larger item in costs of production. The price of ores yielding 60 to 65 per cent of iron at Pittsburgh ranged in the middle seventies—during a period of depression in the industry—between $10 and $12 a ton, and the cost of a mixture of these richer western ores with those of local origin, averaged to yield 50 per cent of iron, was not less than $9. This was $2 or more in excess of the average cost throughout the country, but it was offset by the cheapness of fuel and fluxes at Pittsburgh. Half of the price of ore at this center represented freights, and approximately the same condition prevailed in most important furnace centers of the Union.[1]

The history of our ore trade during the next two decades is characterized by the great expansion of output in the Lake Superior region, accompanied by perfected methods of transportation and some shifting of blast-furnace production to points intermediate between fuel and ore centers. At the same time there was a large growth in the iron output of northern Alabama, where fuel and ore were found in the same vicinity. Contrary to popular expectation, Missouri ceased to be an important ore-producing state. On the other hand, new mines were opened and old mines increased their

[1] American Iron and Steel Association, *Bulletin*, IX, 33–36, Feb. 12, 1875.

output, in some cases very largely, in the older ore districts east of the Alleghenies.

NEW ORE RANGES ON LAKE SUPERIOR

At the opening of this period, Lake Superior ores came from the Marquette range, where the pioneer mines had been opened before the Civil War. If the presence of rich deposits in other regions tributary to the Upper Lake Basin was suspected, it had not been demonstrated and the development of the country and the demand for larger supplies of mineral had not reached a point to encourage their exploitation. Lake shipments in 1873 were 1,179,000 tons, and exceeded those of any preceding or following year until 1879.[2] After the panic there was a sudden decline of more than one-third the quantity mined. In the spring of 1874, the best Lake Superior ores were offered freely at Cleveland for $9.50 a ton. Many of the shipments which came down the Lakes were made in order to employ vessels chartered for a term of years to transport ore, whose masters insisted upon receiving cargoes.[3] There was some recovery in 1876, but no marked improvement occurred in the trade until 1878, when shipments almost reached the figures of the banner year of 1873.[4] The next season witnessed an abrupt recovery, which was followed by several successive years of remarkable expansion. In 1880 the output was nearly 2,000,000 tons. The following year the quantity shipped down the lake was 2,200,000 tons in addition to rail shipments and ore used by local furnaces. About two-thirds of this ore came from the Marquette range and one-third from the Menomenee range, the greater part passing through the port of Escanaba.[5]

The opening of the Menomenee mines, which produced a soft hematite, in 1877 contributed largely to the rapid expansion of output at this time. By 1880 this range was producing about 600,000 tons a year at an average cost of $2 per ton at the mine. In 1885 the first shipment of iron from the Gogebic region to Ashland occurred.[6] One year later the output of this region reached 700,000 tons.[7] Simultaneously exploration was going on in the then unsettled forest region of northern Minnesota, and a railway was under construction into what is now known as the Vermilion district. In 1884 the first ore from the mines there reached Two Harbors, and the following season well toward 200,000 tons were shipped down the Lakes from this source.[8] Toward the end of the decade the Mesabi mines in the same

[2] American Iron and Steel Association, *Bulletin*, VIII, 124, Apr. 16, 1874.

[3] American Iron and Steel Association, *Bulletin*, VIII, 174, June 4, 1874.

[4] American Iron and Steel Association, *Bulletin*, X, 281, Oct. 25, 1876; XIII, 5, Jan. 8, 1879.

[5] American Iron and Steel Association, *Bulletin*, XIV, 308, Dec. 15, 1880; XV, 323, Dec. 21, 1881; XV, 333, Dec. 28, 1881.

[6] Mussey, *Combination in the Mining Industry*, 76; American Iron and Steel Association, *Bulletin*, XIV, 258, Oct. 20–27, 1880; XXIV, 42, Feb. 12, 1890.

[7] American Iron and Steel Association, *Bulletin*, XIX, 213, Aug. 12, 1885; XX, 325, Dec. 8, 1886.

[8] American Iron and Steel Association, *Bulletin*, XVI, 75, Mar. 15, 1882; XVI, 269, Oct. 4, 1882; XVII, 177, July 4, 1883; XVIII, 213, Aug. 20, 1884; XIX, 212, Aug. 12, 1885; XXI, 138, May 25, 1887.

state were discovered, but though they were developed with great rapidity, they did not become important producers during the period we are describing. All these ores were of first class Bessemer quality, though differing in physical appearance. Those from the Vermilion range were hard specular ores, like those first mined on Lake Superior in the Marquette district, while the Mesabi ores were soft. The former required drilling and blasting, the latter were dug with steam shovels. In fact the progress of mining in the Vermilion district was attributed largely to the air drill and giant powder.[9]

LAKE SUPERIOR OUTPUT AND PRICES

In 1890, when shipments from the Lake Superior region exceeded 9,000,000 tons—as compared with an average of less than 1,000,000 tons during the decade ending with 1880—the Marquette range produced in round numbers 3,000,000 tons, the Gogebic range 2,850,000 tons, the Menomenee range 2,280,000 tons, and the Vermilion Lake District 880,000 tons.[10] During the 20 years between a boom production of less than 1,120,000 tons and a boom production of over 9,000,000 tons, the price of standard Bessemer ores from Lake Superior, delivered at Cleveland, Ohio, declined from $12 a ton to less than $4 a ton. Even in the midst of the depression in the middle seventies the average price received for Lake Superior ores at Cleveland was about $7.50 a ton.[11] The subsequent fall in prices was due only in a small degree to lowered mining costs, the principal reductions being in transportation and handling charges. Missouri ores were delivered at St. Louis in 1879 at $5 a ton.[12] New Jersey ores advanced during 1880 from $3.25 to $5.50 per ton, loaded on cars at the mine.[13] This is about the price that mines in northern New York asked for their product.[14] In 1880 contract prices were very high, ore being sold for $12.50 on the dock at Cleveland, though this was immediately followed by a reduction of nearly 25 per cent.[15]

During the early eighties there was much complaint about the high prices which Lake Superior ore producers were demanding of eastern furnace men; and indeed at this time the former seem to have had the whip hand over the latter. By 1883 the furnace owners had organized to secure lower prices and what was called "the war with ore producers" began.[16] In fact

[9] American Iron and Steel Association, *Bulletin*, xxv, 346, Nov. 25, 1891; xvxi, 353, Dec. 7, 1892; Michigan, Commissioner of Mineral Statistics, *Mines and Mineral Statistics*, 1900; Mussey, *Combination in the Mining Industry*, 105–110.

[10] American Iron and Steel Association, *Bulletin*, xxv, 45, Feb. 18, 1891.

[11] Mussey, *Combination in the Mining Industry*, 166; American Iron and Steel Association, *Bulletin*, vii, 205, Feb. 26, 1873; ix, 163, June 4, 1875; xxviii, 203, Sept. 12, 1894.

[12] *St. Louis Journal of Commerce*, quoted in American Iron and Steel Association, *Bulletin*, xiii, 275, Oct. 29, 1879.

[13] American Iron and Steel Association, *Bulletin*, xiv, 5, Jan. 7, 1880.

[14] American Iron and Steel Association, *Bulletin*, x, 99, Mar. 29, 1876.

[15] American Iron and Steel Association, *Bulletin*, xiv, 125, May 19 and 26, 1880; xiv, 138, June 9, 1880.

[16] American Iron and Steel Association, *Bulletin*, xvii, 89, Apr. 4, 1883; xvii, 171, June 27, 1883.

the scarcity and high price of ores had not a little to do with stimulating the exploration and development which brought the Gogebic and Vermilion districts into the market. This temporary shortage of Bessemer ores probably accounts also, in a measure, for the vigorous effort made at this time to perfect the basic process in America and thus to enable southern ores and southern pig to compete with Bessemer pig at the steel furnaces.[17]

From this period of high ore prices dates a general decline, which was not materially interrupted until the crisis of 1893. In 1882, as we have said, there was a considerable reduction from the maximum, and in 1883 the highest sales at contract in Cleveland were for about $7.50 a ton. Two years later the price had fallen to $5.75, some non-Bessemer ore selling for as low as $3.50.[18] Southern ores were very cheap in the vicinity of local furnaces, costing in Tennessee and Georgia $1.50 a ton and upward, and in Alabama only $1.35 a ton; and a report in 1885 stated that two Alabama furnaces had a five-year contract for ore delivered into the top of the furnace for 75 cents a ton.[19] Quite naturally steel men were eager to perfect a process which would enable them to use pig made from these cheaper materials. On the other hand they began to cast about for their own Bessemer ore supplies. It was estimated in 1887 that including royalties and carriage as well as cost of mining, Gogebic ores could be put down at Cleveland for about $5 a ton. Lake freights at this time ranged from $1.65 a ton upward. Prices did not exceed $6 a ton this year.[20]

Both furnace men and mine owners felt at this time that vessel owners were extorting an undue share of the price of ore delivered. By the opening of 1892 freights to Lake Erie ports had fallen to $1 and $1.25 a ton and Bessemer ores for a time sold below $4 at Cleveland.[21] The following year it was intimated that Mesabi ore, which could be mined more cheaply than the specular Bessemer, could be put in the Lower Lake market for $3.75. But only the most favorably situated and best-managed mines could make money, or indeed cover their expenses, at these rates.[22] The period closes with the soft ores from northern Minnesota controlling the market and lake freights well below $1 a ton.

CONSOLIDATIONS IN THE LAKE SUPERIOR REGION

Shortly before 1893 two new developments occurred in the organization of the mining industry of the Lake Superior district. Large companies, financed in part by eastern capitalists, were formed to control these properties. The Lake Superior Consolidated Iron Company, with a capital of $10,000,000, owned 11 of the Gogebic mines and 3 mines in the western

[17] American Iron and Steel Association, *Bulletin*, XVII, 315, Nov. 14, 1883.
[18] American Iron and Steel Association, *Bulletin*, XIX, 84, Apr. 1, 1885; XIX, 157, June 17, 1885.
[19] American Iron and Steel Association, *Bulletin*, XIX, 195, July 22 and 29, 1885.
[20] American Iron and Steel Association, *Bulletin*, XXI, 226, Aug. 24, 1887.
[21] American Iron and Steel Association, *Bulletin*, XXVI, 30, Feb. 3, 1892.
[22] *Iron Age*, LI, 88, Jan. 12, 1893; American Iron and Steel Association, *Bulletin*, XXVII, 164, May 31, 1893; XXVII, 318, Oct. 25, 1893.

end of the Menomenee range. The Gogebic mines produced Bessemer ore, the Menomenee mines foundry and machine iron ore. Certain eastern furnace men were interested in this corporation. The second large amalgamation in the Gogebic district was the Bessemer Consolidated Iron Company, with a capital of $7,500,000, owning 5 of the Gogebic mines. In addition some independent producers were left in this territory. Simultaneously the Great Lake Steamship Company was organized with a capital of $4,000,000 to construct a fleet of 15 iron freighters to be used exclusively for carrying ore, in order to handle the output of the two large corporations mentioned. But all of these pioneer consolidations were dissolved within a year and the properties they controlled were returned to the original owners.[23]

About this time—though the history properly belongs to a later period—great eastern iron masters, notably Andrew Carnegie, began directly or indirectly to acquire interests in properties in this region.[24] In 1891 important mining, rail and steamship companies tributary to the Vermilion ore district were grouped together in a single corporation; and in 1893 the Lake Superior Consolidated Iron Mines, a corporation with $30,000,000, was organized, partly with Rockefeller capital, to control important iron properties in the Mesabi and in the Gogebic range. The same company, which was reported also to have an interest in the Spanish-American mines in Cuba, controlled a fleet of 25 whaleback steamships and barges, railroads to the mines and ore docks at the principal shipping and receiving ports.[25] The period ends, therefore, with the dawning of the so-called vertical organization of the entire iron and steel industry. Eastern iron masters were buying interests in great mining corporations and mining corporations were taking measures—or had perfected them—to control their own shipping facilities.

EASTERN AND SOUTHERN ORES

Although the Lake Superior mines supplied a growing proportion of the iron ores smelted in the United States, they by no means monopolized the market. In 1892, when the ore mined in the country reached its maximum for this period—in round numbers 17,000,000 tons—the Lake Superior ranges produced slightly over 9,500,000 tons, or about 56 per cent of the total. Of the remainder nearly 4,000,000 tons were mined in the South, the output from that region having more than quadrupled within a decade.[26] At this time the growth of mining in the Alabama-Tennessee field was still retarded by the unsuitability of the basic ores of this region for Bessemer

[23] American Iron and Steel Association, *Bulletin*, XXI, 229, Aug. 24, 1887; XXII, 67, Feb. 29, 1888.

[24] American Iron and Steel Association, *Bulletin*, XXV, 13, Jan. 14, 1891; Bridge, *Inside History of the Carnegie Steel Company*, 257–268.

[25] American Iron and Steel Association, *Bulletin*, XXV, 237, Aug. 12, 1891; *Commercial and Financial Chronicle*, LVII, 422–423, Sept. 9, 1893.

[26] American Iron and Steel Association, *Bulletin*, XXX, 253, Nov. 10, 1896; *Manufacturers' Record*, LXVI, 39, Oct. 15, 1914.

steel making. Nor should we overlook the fact that until well toward the end of this period, the Cornwall ore bank in eastern Pennsylvania continued to be the largest single iron mine in the country. In 1888 it yielded 723,000 tons, after having been in operation for 150 years, during which period it had produced nearly 9,500,000 tons of ore.[27]

Champlain ores were also extensively mined. Essex County, which produced in 1885 more than half a million tons, rivaled even the larger ore counties of northern Michigan in total output.[28] The old mines of New Jersey increased their production until the early eighties, when a decline set in, due partly to the competition of ores from abroad.[29] Some ore was mined along the line of the Union Pacific Railroad in Wyoming before 1873, for use as a flux at the Utah Smelters.[30] With the exhaustion of the Iron Mountain and Pilot Knob deposits, during the late eighties, Missouri lost rank as an ore-producing state.[31] In 1889 it was estimated that one-fourth of the world's output of iron ore was mined in the United States; and yet ten years before it had been seriously alleged that our available supply was insufficient to keep our furnaces running.[32] This change in the status of the industry was due to the improvement of transportation more than to the discovery and development of hitherto unknown mineral deposits.

Therefore the geography of iron and steel making in its relation to domestic raw materials was in 1892 roughly as follows: The eastern coastal district was still using mainly the brown hematites, and the magnetites of the Cornwall district, New Jersey, and of northern New York, plus considerable quantities of Lake Superior and foreign ores. The industry in western Pennsylvania, of which Pittsburgh was the center, employed some local ores, principally carbonates, but was mainly dependent on the rich Bessemer ores of the Lake Superior region. Chicago, which had now become an important metallurgical center, owed its possession of this industry to its being the meeting place of eastern coke and western ore. Birmingham was favored by an unusual concentration of coking coal and easily smelted ore; and the growth of the industry here was limited by the narrow market for its product rather than by lack of raw materials. It was recognized that transportation costs had become a principal factor in the geography of iron smelting. Pittsburgh was drawing its supplies from points several thousand miles apart. When a large furnace owned by the Edgar Thomson Steel Company made its first blast in 1880, it employed a mixture of ores from Lake Superior, Pilot Knob and Spain.[33] In the late eighties Buffalo

[27] American Iron and Steel Association, *Bulletin*, XIX, 211, Aug. 12, 1885; XXIII, 187, July 10, 1889.
[28] American Iron and Steel Association, *Bulletin*, XIX, 211, Aug. 12, 1885.
[29] American Iron and Steel Association, *Bulletin*, XVIII, 101, Apr. 16, 1884; XXIII, 187, July 10, 1889.
[30] American Iron and Steel Association, *Bulletin*, VIII, 124, Apr. 16, 1874.
[31] American Iron and Steel Association, *Bulletin*, XXVI, 74, Mar. 16, 1892.
[32] American Iron and Steel Association, *Bulletin*, XIII, 325, Dec. 17, 1879.
[33] American Iron and Steel Association, *Bulletin*, VIII, 349, Nov. 19, 1874; XIV, 27, Feb. 4, 1880.

acquired added importance as an ore receiving port, largely because Lake Superior ores were trans-shipped there for eastern consumers.[34]

ORE IMPORTS

Iron ore had been imported in a small way for many years, when this business suddenly expanded, about 1880, in order to meet the needs of eastern steel makers for high-grade Bessemer pig.[35] The principal trans-Atlantic sources of supply were northern Spain and Algiers, and the points of importation were Philadelphia and Baltimore. In 1890, 684,000 tons of foreign ore were received at the former port and 481,000 at the latter; and the total imports were slightly under 1,125,000 tons.[36] These ores were mined at a low cost, coming as they did from cheap labor countries, and were carried across the Atlantic for less than the railroad freight on ore from neighboring mines, inasmuch as they furnished a backload for grain ships and sometimes came almost as ballast.[37] Special ores were brought from Greece and Asia Minor.[38] We also imported British hematite for our Bessemer steel makers.[39] Canada was likewise an occasional source of supply, its ores resembling somewhat those from Lake Superior, and reaching our furnace owners through much the same transportation channels.[40]

In 1884 the first ore reached this country from eastern Cuba, but the larger expansion of this business dates from a later period. The first cargo, shipped by the Juragua mine, was consigned to the Bethlehem Company, which had acquired an interest in large deposits near Santiago. Cuban shipments steadily increased from less than 22,000 tons in 1884 to over 400,000 tons immediately before the war with Spain.[41] With the introduction of Bessemer steel making in the United States a demand arose also for manganese ores. Part of these were imported, but local sources of supply were discovered, of which the most important were in Virginia.[42]

[34] *E.g.* American Iron and Steel Association, *Bulletin*, xxii, 133, Apr. 25, 1888.

[35] American Iron and Steel Association, *Bulletin*, ix, 117, Apr. 23, 1875; ix, 165, June 4, 1875; ix, 211, July 16, 1875; xiv, 11, Jan. 14, 1880; xv, 20, Jan. 19 and 26, 1881.

[36] American Iron and Steel Association, *Bulletin*, xxix, 161, July 20, 1895.

[37] American Iron and Steel Association, *Bulletin*, xvi, 251, Sept. 13 and 20, 1882.

[38] *E.g.* American Iron and Steel Association, *Bulletin*, xxiii, 251, Sept. 11, 1889.

[39] American Iron and Steel Association, *Bulletin*, xiii, 267, Oct. 22, 1879.

[40] American Iron and Steel Association, *Bulletin*, xvi, 189, July 12, 1882; xxi, 149, June 1 and 8, 1887.

[41] American Iron and Steel Association,, *Bulletin*, xvii, 89, Apr. 4, 1883; xviii, 245, Sept. 24, 1884; xxxi, 188, Aug. 20, 1897; xxxvi, 167, Nov. 10, 1902.

[42] American Iron and Steel Association, *Bulletin*, xx, 123, May 12, 1886.

CHAPTER XVIII

BLAST FURNACES IN THE NORTH AND WEST

GEOGRAPHY OF IRON SMELTING

In 1880 when we produced more than 4,000,000 tons of iron, Pennsylvania was credited with nearly half the total. The Central West produced about 1,200,000 tons, New York, New Jersey and New England 600,000 tons, the South 400,000 tons, and the Pacific Coast 5,000 tons.[1] During the decade which followed, southern pig for the first time appeared in quantities in the northern and eastern market. Railroads gave extremely low rates to Southern iron masters in order to enable them to run at full capacity. Transportation companies received much of their local traffic from furnaces and furnace employes, because they hauled ore and coke to the former and supplies to the latter. If by carrying the pig iron made by these furnaces at cost the railways could keep the plants in steady operation, it was to their interest to do so; for they could still make profit on the other services which they performed for the iron masters tributary to their lines.[2] Thus it happened that by the middle eighties Alabama charcoal irons were competing with those of Michigan in the Boston, New York, Philadelphia and Baltimore markets.

About this time observers thought they could discover signs of a decline in eastern furnaces. They attributed this to high railway charges upon the ores, fuels and fluxes used by the latter, and to Southern competition.[3] Between 1880 and 1888 the pig iron made in New York and New Jersey, for instance, fell from 575,000 to 259,000 tons, while the quantity made in Alabama and Tennessee rose from 148,000 to 717,000 tons. Most of the charcoal furnaces of the North had already been abandoned on account of the growing scarcity of fuel, and in many instances because of the inferior quality of their ores. Indeed, this was, as we shall see later, a period of rapid transition in metallurgical methods and in transportation conditions, during which a great number of small plants were swept out of existence, production was concentrated at strategic centers, and the geography of the entire industry was appreciably modified.[4]

[1] American Iron and Steel Association, *Bulletin*, XVII, 149, May 30, 1883.
[2] American Iron and Steel Association, *Bulletin*, XVIII, 253, Oct. 1, 1884.
[3] American Iron and Steel Association, *Bulletin*, XXIII, 81, Mar. 27, 1889; XXV, 45, Feb. 18, 1891.
[4] American Iron and Steel Association, *Bulletin*, XXIII, 260, Sept. 18, 1889; Butler, *Fifty Years of Iron and Steel*, 24.

Blast furnaces showed no further tendency to concentrate in the vicinity of their markets. Philadelphia, which was a leading center for the consumption of iron on account of its great engineering works and machine shops, smelted less iron and made less steel in the middle eighties than it did in 1870. Cincinnati, Milwaukee, Detroit, St. Louis, Baltimore, Buffalo and Boston made little progress, or actually declined as producers of raw iron and steel, although they were important users of those metals, while Pittsburgh, Chicago and Wheeling made an advance. New York City was never a furnace center.[5]

NEW ENGLAND FURNACES

These twenty years witnessed little expansion of the iron industry in New England, and whatever growth occurred was confined to a single locality. The Katahdin Iron Works in Maine, after many vicissitudes, including insolvency, a protracted shut-down and a remodeling, were finally sold in 1892 and the machinery removed to Nova Scotia.[6] Vermont practically ceased to make iron, although a new bloomery was erected there in 1880 in the hope of producing iron suitable for the best quality of steel.[7] Rhode Island, where iron had been made in colonial days, had long since been without a single furnace, although it possessed considerable bodies of ore and coal that is said at one time to have been shipped to Pittsburgh to be used as a fuel in making blooms.[8]

But the principal iron-making center of New England remained where it had been for over a century, in the Berkshires and the Salisbury district of Connecticut. In 1874 the old iron mine in Salisbury, which had been worked more than 150 years, declared an annual dividend of 115 per cent and the Lanesboro Furnace concluded a record run of 89 weeks, during which it produced nearly 6,000 tons of car-wheel iron. In 1887 eight neighboring furnaces were deriving their ore from the Salisbury district. All the iron made in this region was smelted with charcoal, although in some instances anthracite had previously been used.[9]

As recently as 1891 the New England pig-iron industry was reported to be "in a very healthy condition." The annual output of this group of states had risen from 34,000 tons in 1856 to more than 40,000 tons in 1888, a trifling quantity compared with the product of furnaces elsewhere, but important because of its relation to neighboring industries. At the latter date 13 charcoal furnaces were in blast in New England, producing pig solely for local foundry use.[10] While the number of iron and steel works—

[5] American Iron and Steel Association, *Bulletin*, xx, 229, Sept. 1, 1886; Bridge, *Inside History of the Carnegie Steel Company*, 141.

[6] American Iron and Steel Association, *Bulletin*, VIII, 124, Apr. 16, 1874; XIV, 139, June 9, 1880; XVI, 316, Nov. 29, 1882; XIX, 221, Aug. 19, 1885; XXIII, 13, Jan. 16, 1889; XXVI, 125, May 4, 1892.

[7] American Iron and Steel Association, *Bulletin*, XIV, 157, June 23 and 30, 1880.

[8] American Iron and Steel Association, *Bulletin*, XXI, 180, July 6, 1887.

[9] American Iron and Steel Association, *Bulletin*, VIII, 187, June 18, 1874; VIII, 227, July 23, 1874; XI, 313, Dec. 5, 1877; XV, 234, Sept. 21, 1881; XX, 229, Sept. 1, 1886.

[10] American Iron and Steel Association, *Bulletin*, XXIII, 260, Sept. 18, 1889; XXIII, 323, Nov. 27, 1889; XXV, 212, July 22, 1891 (Suppl.); XXVI, 25, Feb. 3, 1892.

limiting the term to furnaces, forges, bloomeries, rolling mills and Bessemer, open-hearth or crucible steel works—declined from 48 to 35 between 1870 and 1890, the capital invested in them more than doubled, and a corresponding increase occurred in the number of hands employed and in the value of product.

Nevertheless the competition of the West was seriously felt and it was generally recognized that primary iron manufacturing in this section was bound to decline or disappear even though metal-working industries might multiply. The Fall River Iron Works shut down permanently in 1887 after more than 60 years of operation and after running for several seasons at a loss; and the company that owned them devoted all its capital thereafter to cotton spinning and weaving. A leading stockholder of the corporation explained at the time that in order to compete in certain important markets with Southern or Western rivals who paid but a single freight, New England manufacturers had to pay four freights; for bringing pig iron to Fall River from Pennsylvania or Birmingham, for the tranportation of coal to convert that iron into finished products, for additional freight upon containers, and for the extra charge of delivering goods to Western consumers. In the cost of making print cloths, freight charges were less than 0.5 per cent, while in the manufacture of nails they were 15 times that amount. The employment of natural gas as a fuel in the West still further increased the relative disadvantage under which New England manufacturers of many classes of metal articles labored.[11]

IRON SMELTING IN THE CENTRAL ATLANTIC STATES

Similar influences were affecting, though in less degree and more tardily, the production of pig iron in New York and New Jersey. Most of the New York furnaces and forges were tributary to the Hudson River and Lake Champlain. These were distinguished from the furnaces of the Salisbury and Berkshire district mainly by being more accessible to water carriage. Consequently the Hudson furnaces used coal or coke instead of charcoal and a greater variety of ores. These twenty years were for them a period of fluctuating prosperity. The panic of 1873 temporarily closed the steel works at Troy, but did not prevent the completion of a furnace intended to make Bessemer pig its specialty at Port Henry, New York.[12] Thereafter iron and steel industries of Troy continued to lag until 1885, when the Albany and the Rensselaer companies combined and erected three blast furnaces near that city, where it was proposed to use Champlain ores and western coke.[13] The Poughkeepsie furnaces remained in operation and about 1885 other Hudson Valley furnaces were repaired and relighted.[14]

[11] American Iron and Steel Association, *Bulletin*, XXI, 37, Feb. 9, 1887; XXIII, 257, Sept. 18, 1889.

[12] American Iron and Steel Association, *Bulletin*, VIII, 236, July 30, 1874; X, 74, Mar. 8, 1876.

[13] American Iron and Steel Association, *Bulletin*, XIX, 99, Apr. 15, 1885.

[14] American Iron and Steel Association, *Bulletin*, XIX, 269, Oct. 7, 1885; XX, 5, Jan. 6, 1886; XX, 333, Dec. 15, 1886.

But the iron and steel industries were more or less decadent in this region. The stove industry was moving westward, and the manufacture of steel rails was drifting in the same direction. Although in 1892 something of a revival occurred and it was hoped with new economies and improvements to produce iron at between $12.50 and $13.50 a ton, this period did not close with hopeful prospects for such enterprises.[15]

Another branch of the industry characteristic of the Champlain area remains to be mentioned. In the middle seventies some 25 Catalan forges were still in operation in the Adirondack region, producing about 40,000 tons of blooms annually. For ten years or more this iron had been used almost exclusively by makers of crucible cast steel, the greater part being sold at Pittsburgh. Billets made at these forges were remarkably free from deleterious impurities but varied in carbon content. The latter defect was not a serious objection in crucible steel-making. New establishments of this kind continued to be erected, and in 1878 a charcoal furnace with a bloomery forge went into blast near Plattsburg.[16]

At Buffalo and along the Erie Canal several trials were made at producing iron from ore and fuel brought by water from the West. The Kirkland Company at Utica, New York, rebuilt and improved its furnace in 1883.[17]

Many of the New Jersey furnaces like those of the Hudson Valley used anthracite coal for smelting. After the long depression that followed the panic of 1873, the iron industry of that state rallied in 1879 and there was some new construction during the following decade. In 1889 the Oxford Furnace, which had been erected in 1742 and shared with the Cornwall furnace in Pennsylvania the honor of being the oldest establishment of the kind still standing in the United States, was finally torn down.[18] Between 1880 and 1890, the number of furnaces in New York fell from 57 to 37, but their capacity rose from 313,000 to 344,000 tons per annum. Though the number of furnaces in New Jersey did not decline so markedly, falling only from 20 to 18, their capacity decreased from 157,000 to 145,000 tons. This decade marked a turning point of the industry in both states, when growth, which had been continuous up to 1880, ceased and decay set in. In New York, despite the slight addition to furnace capacity, primary iron and steel production was practically stationary, because the number of Catalan forges decreased by half, and many of those which remained in existence were idle.[19]

In 1874 superficial observers predicted that Pennsylvania would soon lose its supremacy as a producer of iron and steel. It is unnecessary to

[15] American Iron and Steel Association, *Bulletin*, xxvi, 211, July 20, 1892.

[16] American Iron and Steel Association, *Bulletin*, ix, 250, Aug. 20, 1875; xii, 130, June 5, 1878; xvii, 172, June 7, 1893.

[17] American Iron and Steel Association, *Bulletin*, xvii, 17, Jan. 24, 1883.

[18] American Iron and Steel Association, *Bulletin*, x, 74, Mar. 8, 1876; xiii, 213, Aug. 20 and 27, 1879; xiii, 13, Jan. 16, 1889.

[19] American Iron and Steel Association, *Bulletin*, xxvii, 172, June 7, 1893; Eleventh Census, *Report on Manufactures, Selected Industries*, Part ii, 396.

dwell upon the falsification of this prophecy. It was based on the great development which was occurring, or at least was foreseen, in the Middle West and the South. Pennsylvania produced very nearly half the pig iron made in the United States; but her iron makers were now confronted by local competition in communities which formerly received their iron exclusively from them. With the decline in railroad building and the substitution of steel for iron rails, which could be manufactured to advantage farther west, the furnace men of eastern Pennsylvania looked forward to an abruptly restricted market. They felt the effects of the crisis of 1873 more keenly for this reason and their pessimism was, in the light of their knowledge and experience at the time, by no means unjustified.[20] But this sentiment was not universal and new furnaces were erected in the midst of the depression.[21]

A novel fact in the furnace industry of eastern Pennsylvania at this time was that nine charcoal furnaces depending upon local timber for their fuel were in operation within less than 40 miles of Philadelphia—a striking comment upon the survival of hardwood forests in that region in spite of 200 years of settlement and the proximity of a city with nearly a million people. The retarded development which made this industry possible was ascribed to the long survival of the Penn Manors in which all these furnaces were situated. The owners made no important improvements within the bounds of these vast estates, which for the most part lay completely waste until after the American Revolution, diverting the current of progress for nearly a century thereafter to regions farther west.[22]

In 1875 evidences of revival from the stagnation that followed the panic began to be noticeable in the Schuylkill Valley. That year the Philadelphia and Reading Coal and Iron Company contracted with the principal furnaces along the Reading Railroad to supply them with raw materials and to take their product off their hands for the cost of manufacture,[23] and the Bethlehem Iron Company completed three anthracite furnaces. Other new establishments were under construction in the same vicinity.[24] The Lehigh Valley, at this time perhaps the most important iron-producing district in the United States, had been very prosperous until the panic broke. Following the shock of that event and the ensuing depression, furnace owners betook themselves, under the compulsion of western competition, to improving their plants and processes. In this they were so successful that they increased their average daily output per furnace more than fourfold during the two decades we are now describing. In this struggle many a flourishing company succumbed, only to be followed by a more enterprising

[20] American Iron and Steel Association, *Bulletin*, VIII, 84, Mar. 12, 1874; IX, 132, May 7, 1875.

[21] *E.g.* American Iron and Steel Association, *Bulletin*, VIII, 204, July 2, 1874; VIII, 221, July 16, 1874; VIII, 283, Sept. 24, 1874.

[22] American Iron and Steel Association, *Bulletin*, IX, 133, May 7, 1875.

[23] American Iron and Steel Association, *Bulletin*, IX, 252, Aug. 20, 1875.

[24] American Iron and Steel Association, *Bulletin*, X, 74, Mar. 8, 1876.

and able successor. As a result of improved construction and methods of operation, fuel consumption and labor costs were reduced by one half.[25]

Although the number of furnaces in Pennsylvania decreased from 269 to 221 between 1880 and 1890, their annual product rose from 1,930,000 tons to 4,868,000 tons.

No iron was made in Delaware during this period. Maryland was passing through the interval between the small furnace era surviving from the eighteenth century, during which charcoal iron was the principal product, and the period of concentrated large-scale production, mostly from foreign ores, which followed the establishment of great steel works at Baltimore. That city had always been the state's leading furnace center, in marked contrast with the position that Philadelphia held in Pennsylvania, New York in New York state, or Boston in New England. Of the 39,000 tons of iron made in Maryland in 1875, some 16,000 tons were smelted in Baltimore; and seven years later the respective figures were 54,524 and 24,462 tons.[26] During 1889 the first of the four giant furnaces of the Pennsylvania Steel Company at Sparrows Point went into blast. This group, which was then approaching completion, was planned to have, when in full operation, an output of beween 300,000 and 400,000 tons per annum.[27] In 1890 the whole state made less than 100,000 tons of pig iron, but this represented an increase of 60 per cent over the quantity produced ten years before.

WESTERN AND GREAT LAKE FURNACES

Considering the Pittsburgh district as part of the West, two zones of furnace activity radiated from that point. One of these followed the Ohio River, touched Wheeling in West Virginia, traversed the old Hanging Rock region of Ohio and Kentucky, and terminated in the new and temporary furnace center at St. Louis. The other stretched out toward the great ore supplies of Lake Superior, through the Shenango and Mahoning Valleys to Cleveland and Detroit, to the Lake shore again at Chicago and Milwaukee, and found its terminus at the very close of the period we are describing in the neighborhood of Duluth.

Pittsburgh owes its importance as a blast-furnace center, which it did not attain until long after it became the principal iron manufacturing city in America, chiefly to the presence in its vicinity of the first large bed of coking coal to be developed in this country. In 1871, when the Isabella and Lucy Furnace groups were begun there, simultaneously but as separate enterprises, only seven small blast furnaces, producing in the aggregate about 70,000 tons of pig iron per annum, existed in the vicinity. The growth of coke-burning in the Connellsville district and of ore smelting in Pittsburgh went hand in hand.[28] That city's iron masters were the first

[25] American Iron and Steel Association, *Bulletin*, XVIII, 281, Nov. 5, 1884; XXX, 11, Jan. 10, 1896.
[26] American Iron and Steel Association, *Bulletin*, XVII, 237, Aug. 29, 1883.
[27] American Iron and Steel Association, *Bulletin*, XXIII, 301, Oct. 30, 1889.
[28] Bridge, *Inside History of the Carnegie Steel Company*, 54–55, 141.

to employ the high-temperature blasts and huge furnace stacks which were to revolutionize production statistics during the next decade. In 1874 the city made nearly one-third of the 600,000 tons of pig iron consumed by its industries annually. The preceding year the receipts of ore were as follows: from Lake Superior, 203,000 tons; from Iron Mountain, 113,000 tons; from Canada, 20,000 tons; from Lake Champlain, 3,500 tons. To these were added about 6,500 tons of local ore.[29] The first Lucy Furnace, which was built in 1871, was 75 feet high with a 20-foot bosh. A sister furnace known as Lucy No. 2 went into blast in 1877, its completion having been delayed by the depression following the panic. This made the twelfth furnace in Pittsburgh proper. The Edgar Thomson Steel Company immediately started out to rival the furnaces of the Lucy Company and plants turning out 200 tons or more a day ceased to be notable.[29] By 1886 Allegheny County, where modern pig-iron production began in 1859, had 20 furnaces in operation or approaching completion.[30] From this date new establishments were usually connected with the great steel works which soon became so characteristic of this region.

Ohio ranked next to Pennsylvania in the iron industry and its furnace output increased remarkably during this period. The expansion was principally in the Hocking Valley and the Mahoning Valley, the first in the southern section and the latter in the northern section of the state. The Hanging Rock district was an older iron-making region, which received its name from a peculiarly shaped cliff upon the Ohio near which some of the early furnaces were situated, and lay on both sides of the river in Ohio and Kentucky. Native ores were smelted originally with charcoal and later with mineral fuel procured in the same vicinity. In 1872 this district produced more than 24,000 tons of charcoal iron.[31] New furnaces continued to be built south of the river until 1881, after which there was a rapid decline. In 1886 only six furnaces were in blast, and by 1890 but one of the charcoal furnaces continued in operation. Most of these establishments had been small affairs operated by primitive methods. They generally banked up on Sunday and they depended for sales upon the quality of their iron and the prejudice that existed in its favor among the steamship owners, machine makers and stove founders of the Ohio Valley.[32] In 1889 the Watts Iron and Steel Company, an English enterprise alleged to have a capital of $3,000,000, founded the town of Middlesboro, Kentucky, where it planned to erect iron furnaces and a basic steel plant. But the financial stringency abroad, and later in America, hampered this enterprise and the first furnace was not blown in until six years later.[33]

[29] American Iron and Steel Association, *Bulletin*, IX, 44, Feb. 19, 1875; XI, 204, Aug. 1, 1877; XIV, 305, Dec. 15, 1880.
[30] American Iron and Steel Association, *Bulletin*, XX, 229, Sept. 1, 1886.
[31] Kentucky Geological Survey, *Reports of Progress* (New Series), I, 319, 329.
[32] American Iron and Steel Association, *Bulletin*, XIV, 107, May 5, 1880; XX, 229, Sept. 1, 1886; XXIV, 229, Aug. 6 and 13, 1890.
[33] Swank, *Iron in All Ages*, 287; *Manufacturers' Record*, 10, XV, June 29, 1889; XVI, 9, Dec. 14, 1889; XXI, 6, Feb. 20, 1892.

North of the river the industry continued to expand. This was due to the rapid extension of iron-making during the early seventies in the Hocking Valley. Ironton for a time had a national reputation as a furnace center and pig-iron market, and its quotations for this commodity were printed with those of Pittsburg, Cleveland, Chicago and eastern port cities. The Etna Furnace at this point, which was commenced just before the panic of 1873 and went into operation in 1875, was one of the largest and most modern plants in the United States.[34] This valley was favored by the close proximity of its coal and ores. Some of the former were suitable for coking, and of the two ore veins worked, one lay about 100 feet above and the other 30 feet below the main coal seam. In 1876 this ore was delivered at the furnaces by farmers and contractors for $2.50 a ton. Although two charcoal furnaces had been in operation in the region earlier, the principal development began in 1875. Two years later 4 furnaces were in operation and 7 were under construction. In 1882 a company was organized with a capital of $25,000,000 for the purpose of buying up the furnaces of the district, and acquired control of 7 of the 14 then in blast.[35]

Even more promising was the continual expansion of the iron industry in the Mahoning Valley and Shenango Valley as a result of a growing ore supply from Lake Superior and coke shipments from the Connellsville region. Youngstown was an important coal and iron center in 1875. Ten years later the Shenango furnace owners claimed that they could produce iron cheaper than their competitors in any other part of the United States.[36]

Indiana and Illinois—omitting for the moment Chicago and the district tributary to the head of Lake Michigan—made no notable progress in the production of iron and steel during these two decades. The erection of furnaces in Jackson County to use the Big Muddy coal of that vicinity with Missouri ores dates from the late sixties. These enterprises proved but temporarily successful and in 1881 the last furnace in that vicinity ceased operations.[37]

For some years iron smelting in the lower Ohio Valley and the adjacent territory had been drifting toward St. Louis, the natural meeting point in this region of Missouri ore, Illinois coal and eastern coke. Several furnaces designed to burn the latter fuels were erected at East St. Louis and at Carondelet, just south of the city. These enterprises lagged somewhat during the depression that followed the panic of 1873. During a portion of the ensuing year all the 8 or 10 furnaces of the St. Louis district were either out of blast or banked, and in August 1875 only 5 out of the 18 furnaces in the entire state were running.[38] Yet at the same time new

[34] American Iron and Steel Association, *Bulletin*, IX, 131, May 7, 1875; X, 75, Mar. 8, 1876.

[35] American Iron and Steel Association, *Bulletin*, X, 306–307, Nov. 22, 1876; XI, 164, June 13 and 20, 1877; XI, 205, Aug. 1, 1877; *Commercial and Financial Chronicle*, XXXIV, 605, May 27, 1882.

[36] American Iron and Steel Association, *Bulletin*, IX, 149, May 21, 1875; XIX, 260, Sept. 30, 1885.

[37] Swank, *Iron in All Ages*, 318.

[38] American Iron and Steel Association, *Bulletin*, VIII, 211, July 9, 1874; IX, 129, May 7, 1875; IX, 250, Aug. 20, 1875.

furnaces of a modern type, and Bessemer steel works, were under construction.[39]

The Big Muddy coal of Illinois, upon which the iron industry at St. Louis was founded, was an excellent fuel, but it had not hitherto been used successfully in blast furnaces without an admixture of coke. During the years just mentioned the latter was brought from the Connellsville district, via Pittsburgh.[40] In 1878, however, Carbondale coke from Southern Illinois began to be used, and after thorough tests proved satisfactory. It was employed exclusively in the Meier furnaces at East St. Louis in 1881.[41] That year several Missouri mining, blast furnace and transportation companies interested in the iron trade were amalgamated with the Vulcan Iron and Steel Works as the St. Louis Ore and Steel Company. The new corporation controlled 4 furnaces with a capacity of 3,000 tons of Bessemer pigs a week.[42]

During the depression of 1884 all the Missouri furnaces suffered severely. Of the 17 in the state but 3 remained in blast, and several were shut down permanently at this time.[43] Inferior or costly coal continued to check the progress of iron making in this region. In 1885 excellent Bessemer pigs were produced at Carondelet, but only by using Connellsville coke exclusively.[44] During the general revival of the industry in 1886 and 1887 another era of prosperity ensued, and simultaneously interest was awakened in smelting the manganese ores just discovered in Arkansas for the production of ferro-manganese.[45] Several charcoal furnaces in the interior of the state continued in operation; but between 1883 and 1890 their number declined from 9 to 3, and the number of coke furnaces fell from 8 to 5. Missouri's rank as an iron producer fell from sixth among the states in 1870 to thirteenth in 1890, only to decline still further immediately thereafter.

While so large a proportion of the ore mined on Lake Superior was smelted in Ohio and western Pennsylvania that Cleveland had become the principal market for that commodity, nevertheless furnaces were erected nearer the mines wherever fuel was available. Buffalo, Cleveland's rival on the lower lakes, did not fulfill its early promise as a furnace center and for a period in the eighties there was not a pound of iron made in that city. In 1889 one of its older plants was put into blast with Lake Superior and Champlain ores and with coke as fuel. This furnace, which had been originally planned to use anthracite coal, was soon after rebuilt and in 1891 was producing more than 200 tons a day with Superior ore and coke. The following year

[39] American Iron and Steel Association, *Bulletin*, IX, 316, Oct. 22, 1875; X, 75, Mar. 8, 1876.

[40] Kentucky Geological Survey, *Reports of Progress* (New Series), I, 347.

[41] American Iron and Steel Association, *Bulletin*, XII, 137, June 12, 1878; XV, 113, May 4 and 11, 1881.

[42] American Iron and Steel Association, *Bulletin*, XV, 188, July 27, 1881; XVI, 66, Mar. 1 and 8, 1882.

[43] American Iron and Steel Association, *Bulletin*, XVIII, 237, Sept. 17, 1884.

[44] American Iron and Steel Association, *Bulletin*, XIX, 245, Sept. 9, 1885.

[45] American Iron and Steel Association, *Bulletin*, XX, 5, Jan. 6, 1886; XX, 69, Mar. 17, 1886.

a still larger furnace was erected and from this time dates the restoration of Buffalo to the list of important iron-making cities.[46]

Some iron was made in southern Michigan, notably at the Wyandotte Works near Detroit, historic for their early Bessemer experiments,[47] but most of the state's product was smelted with charcoal by furnaces on the Northern Peninsula, in the immediate vicinity of the mines. Although it was still regarded as a frontier town, Marquette had become by 1875 an iron-working city of some importance, and manufactured locomotives, railway cars, steam engines and marine machinery. That year 21 furnaces were in blast on the Upper Peninsula. These plants were small as a rule, producing in the seventies about 1,000 tons of iron a month in the aggregate, though this quantity was occasionally exceeded. By 1880, however, some single charcoal furnaces in that region had this capacity.[48] The industry continued reasonably prosperous up to the close of the period we are discussing. Michigan and Wisconsin together ordinarily produced rather more than 250,000 tons of charcoal iron a year, although the increasing scarcity of fuel was already felt. This iron was used mainly for making malleable castings and carwheels; but by this time coke iron was being substituted for charcoal iron in the former, which still held their market because steel castings commanded much higher prices. Charcoal iron continued to be used generally for carwheels, however, although steel was invading even this market to some extent.[49]

Milwaukee's blast furnaces originally used ore from the south-central part of the state. Before they ceased operating, however, they had come to depend in part, at least, on Lake Superior ores and were being operated in connection with the rolling mills and steel works of Chicago.[50] The furnaces at the latter city and at Joliet were originally erected mainly to supply Bessemer steel to the rail mills with which they were connected. There were exceptions to this rule, however, and in 1892 the new furnaces of the Iroquois Company in Chicago were put into blast for the sole purpose of producing foundry iron.[51] Small furnaces supplying mainly local markets were in operation in southern and central Wisconsin, and in 1888 the principal charcoal furnace in the state was blown in at Ashland. This establishment used Gogebic ore, and about 1890, when it had attained a maximum output of 130 tons a day, it was rated the most efficient charcoal furnace in the world.[52] As early as 1872 a charcoal furnace destined to

[46] American Iron and Steel Association, *Bulletin*, VIII, 163, May 23, 1874; VIII, 324, Oct. 29, 1874; XXIII, 5, Jan. 2 and 9, 1889; XXIII, 181, July 3, 1889; XXV, 324, Nov. 4, 1891; XXVI, 234, Aug. 17, 1892; XXVII, 77, Mar. 8, 1893.

[47] American Iron and Steel Association, *Bulletin*, VIII, 338, Nov. 12, 1874.

[48] American Iron and Steel Association, *Bulletin*, IX, 197, July 2, 1875; IX, 308, Oct. 15, 1875; X, 117, Apr. 12, 1876; X, 129, May 3, 1876; XIV, 261, Oct. 20 and 27, 1880.

[49] American Iron and Steel Association, *Bulletin*, XXVII, 91, Mar. 22 and 29, 1893.

[50] American Iron and Steel Association, *Bulletin*, VIII, 249, Aug. 13, 1874; X, 11, Jan. 12, 1876; XII, 60, Mar. 13, 1878; XIII, 26, Feb. 5, 1879.

[51] American Iron and Steel Association, *Bulletin*, XXV, 285, Sept. 30, 1891.

[52] American Iron and Steel Association, *Bulletin*, XXII, 117, Apr. 11, 1888; XXIV, 125, May 7, 1890.

remain a monument of unfulfilled hopes was begun at Duluth. The panic stopped construction and it was not completed until 1880, when, after producing some 35 tons of iron a day for a short period, it ceased operation.[53] A new furnace intended to use coke was begun at this point in 1888 but was not blown in until two years later. The latter plant made Bessemer pig iron from Mesabi ore for the new steel works at West Superior.[54]

IRON SMELTING IN THE FAR WEST

Only one state farther west than Minnesota established a pig-iron industry destined to become important at this time. A little furnace was built in northern Colorado in 1862, but it was abandoned after it had produced a few hundred tons of pigs. In 1880, however, the Colorado Coal and Iron Company began a large coke furnace at Pueblo which was put into blast the following year and was the first of a group of three large furnaces completed or in process of erection before the end of the period we are now describing. This company was favored by the possession of coking coal as well as Bessemer ores.[55] In 1874 a little charcoal furnace went into blast in Utah and the following year a large plant of the same kind was commenced at Ogden. The latter did not go into operation, however, until 1882, and then only for a brief period. During its short existence it made carwheel iron, some of which was used in a locomotive built in that city.[56]

Each of the Pacific Coast states had a single blast furnace in operation during the period we are describing. Oregon was the pioneer, its plant having been erected as early as 1867. It soon shut down, however, and did not resume until 1874, after which it was in fitful operation for some years. In 1882 the company controlling the plant was reorganized as the Oregon Iron and Steel Company with a capital of $3,000,000. A new furnace was erected in 1883, which like its predecessor used charcoal fuel and produced iron with reasonable regularity throughout the following decade.[57] Both California and Washington entered the ranks of iron producers in 1881. A charcoal furnace was erected at Clipper Gap, California, in 1880, which was put in blast the following spring. It was burned down a year later and rebuilt, but ceased operations in 1886.[58] A little

[53] Swank, *Iron in All Ages*, 341; American Iron and Steel Association, *Bulletin*, XIII, 315, Dec. 10, 1879; XV, 157, June 22, 1881.

[54] American Iron and Steel Association, *Bulletin*, XXII, 67, Feb. 29, 1888; XXII, 157, May 16, 1888; XXIV, 141, May 21, 1890; XXV, 293, Oct. 7, 1891; XXVII, 45, Feb. 8, 1893.

[55] Swank, *Iron in All Ages*, 343–344.

[56] American Iron and Steel Association, *Bulletin*, IX, 93, Apr. 2, 1875; XI, 177, July 4, 1877; XII, 46, Feb. 20 and 27, 1878; XIII, 38, Feb. 12 and 19, 1879; XVI, 250, Sept. 13 and 20, 1882; XVII, 115, May 2, 1883.

[57] American Iron and Steel Association, *Bulletin*, IX, 37, Feb. 12, 1875; IX, 283, Sept. 17 and 24, 1875; X, 11, Jan. 12, 1876; XII, 189, Aug. 14, 1878; XVI, 305, Nov. 15 and 22, 1882; XVII, 269, Sept. 26, 1883; XXII, 149, May 9, 1888.

[58] American Iron and Steel Association, *Bulletin*, XIV, 170, July 14, 1880; XV, 217, Aug. 31, 1881; XVI, 273, Oct. 11, 1882; XVI, 349, Dec. 23, 1882; XVIII, 157, June 18, 1884; XXII, 281, Sept. 19, 1888; XXV, 29, Feb. 4, 1891.

furnace was also erected at Port Townsend, on Puget Sound, in what was then Washington Territory and two years later a new furnace was substituted for this experimental plant. It used bog ore from the immediate vicinity and magnetic ore from British Columbia. Coke ovens were erected in that state in the middle eighties, and some coke was shipped to San Francisco. The Port Townsend furnace went out of blast in 1889 and did not resume operations during the period we are now discussing.[59]

The principal obstacle to the development of a prosperous blast-furnace industry on the Pacific coast was the lack of suitable fuel. Fir charcoal was used at Port Townsend, partly because the coking coals of British Columbia and Vancouver had not yet been successfully developed. Labor was expensive and machinery had to be imported or brought from the East. On the other hand the foundries, machine shops, rolling mills and shipyards of the Pacific coast afforded an active market for pig iron, which local producers were never able fully to supply. In 1881 it was estimated that the three furnaces of the Coast, all of which chanced to be in operation that year, would produce about 19,000 tons of iron, leaving a deficit of 6,000 tons to come from the Atlantic states and Europe. The average price of iron in the San Francisco market for the previous five years had been $30.[60]

[59] American Iron and Steel Association, *Bulletin*, XIII, 308, Dec. 3, 1879; XV, 92, Apr. 13, 1881; XVII, 52, Feb. 21, 1883; XIX, 122, May 13, 1885; XXI, 194, July 20, 1887; XXII, 13, Jan. 11, 1888; XXIII, 98, Apr. 10, 1889; XXV, 339, Nov. 18, 1891.

[60] American Iron and Steel Association, *Bulletin*, XVI, 36, Feb. 1, 1882; Hittell, *Commerce and Industry of the Pacific Coast*, 654–655.

CHAPTER XIX

NEW IRON INDUSTRY OF THE SOUTH

PRIMITIVE SURVIVALS

Iron smelting increased rapidly in the South during the twenty years of restored and augmented prosperity which followed that section's recovery from the prostration of the Civil War and the ensuing panic of 1873. This progress was mainly in three states, Virginia, Tennessee and Alabama. Indeed, very little iron was smelted elsewhere. North Carolina had one of the few Bessemer ore beds in that part of the Union and several projects for manufacturing iron there were at various times under consideration. These finally resulted in the erection of a furnace about 1890, when Pocahontas coke became available for fuel. Bloomeries and one or two little charcoal furnaces had been operated at intervals in the western part of that state ever since the Civil War, but they were of trifling importance in the iron industry of the country as a whole.[1] The history of the old charcoal furnaces of Georgia was very similar.[2] No iron was made in the lower Mississippi Valley, though Texas had a few furnaces, one of which was operated by the state. In 1889 charcoal furnaces were erected at New Birmingham, which manufactured castings for sale throughout the southwest.[3]

These small local enterprises contributed little to the nation's total iron product and most of them were survivals, or revivals, of the type of industries common earlier in the century. But the blast furnaces erected at this time in Virginia, Tennessee and Alabama belong to the modern industrial era; and they rapidly supplanted the old charcoal furnaces and bloomeries which survived in some instances from the days of the Revolution until several years after the Civil War.[4]

VIRGINIA FURNACES

Despite the depression of the middle seventies larger charcoal furnaces and a few coke furnaces using fuel from the North were erected in Virginia

[1] American Iron and Steel Association, *Bulletin*, VIII, 221, July 16, 1874; XIII, 4, Jan. 8, 1879; XVII, 83, Mar. 28, 1883; XXIV, 205, July 16, 1890; XXVIII, 229, Oct. 10, 1894; *Boston Journal of Commerce*, XXXIX, 185, Dec. 26, 1891.

[2] *E.g.* American Iron and Steel Association, *Bulletin*, X, 74, Mar. 8, 1876.

[3] American Iron and Steel Association, *Bulletin*, XI, 164, June 13 and 20, 1877; XVIII, 25, Jan. 23 and 30, 1884; XXV, 205, July 8 and 15, 1891.

[4] American Iron and Steel Association, *Bulletin*, VIII, 205, July 2, 1874.

at that time. In 1875 a Baltimore firm bought the Mount Vernon Iron Works in Rockingham County, embracing a cold-blast charcoal furnace built in 1848 and an eight-fire bloomery.[5] It was estimated that good iron could be made in that section for less than $17 a ton at the furnace, and that the foundries and machine shops of Richmond and the growing towns farther west would afford a ready market for the product. Lynchburg, for example, had became a local iron-manufacturing center of some importance.[6] The building of the Chesapeake and Ohio Railway gave an impetus to the industry; and the coke furnaces which went into operation at this time brought their fuel from the Connellsville district. About 1880 Pennsylvania and English capital was invested in Virginia mines and furnaces.[7] In 1881 six active iron works were in operation within a distance of 50 miles along the Chesapeake and Ohio Railway, and two years later what was described as the largest furnace in the United States, though it was hardly to be compared with the big Pittsburgh stacks in output, went into blast in Rockbridge County. It was owned by a British company and made about 2,600 tons of foundry iron a month. That year Pocahontas coke came into the market in commercial quantities and the new furnace was designed to employ this fuel.[8]

With the opening of this coke region new plants and processes were substituted for most of the happy-go-lucky charcoal furnaces which still survived. In 1884 there were still 31 of the latter in Virginia, producing about 15,000 tons of pigs per annum, or the same quantity as ten years before. Twelve furnaces using mineral fuel made in the aggregate about ten times as much iron as their charcoal neighbors.[9] The census of 1890 showed that Virginia had risen within a decade from the seventeenth to the sixth place among the states as an iron producer. In 1891, eight new furnaces were under construction. These promised to increase the state's annual output by more than 300,000 tons, but also threatened to outrun the supply of local ore. The climax of this iron boom, which placed Virginia at the head of the Southern states as a furnace builder, came soon after 1890, at which time there were 11 modern coke stacks on the line of the Norfolk and Western Railway alone.[10]

IRON SMELTING IN TENNESSEE

Tennessee's new iron industry—for modern iron making in that state had no direct historical connection with her earlier charcoal furnaces – dates

[5] American Iron and Steel Association, *Bulletin*, IX, 269, Sept. 3, 1875; X, 74, Mar. 8, 1876.

[6] American Iron and Steel Association, *Bulletin*, VIII, 399, Dec. 31, 1874; XII, 106, May 8, 1878; XIII, 196, Aug. 6, 1879; *Virginia, A Geographical and Political Summary*, 113.

[7] American Iron and Steel Association, *Bulletin*, XIV, 60, Mar. 10, 1880; XIV, 237, Sept. 22 and 29, 1880; XV, 115, May 4 and 11, 1881; XV, 267, Oct. 19 and 26, 1881.

[8] American Iron and Steel Association, *Bulletin*, XVII, 141, May 23, 1883; XVII, 171, June 27, 1883; XVII, 241, Sept. 5, 1883.

[9] *Manufacturers' Record*, VII, 745, July 25, 1885.

[10] American Iron and Steel Association, *Bulletin*, XXV, 67, Mar. 11, 1891; XXV, 357, Dec. 2, 1891; XXVI, 50, Feb. 24, 1892; XXVI, 92, Apr. 6, 1892.

from the discovery in the seventies that local coal was suitable for coking. Its center was Chattanooga and its development was closely associated with that of this city's younger neighbor, Birmingham, Alabama. Chattanooga had been a manufacturing town of some local importance before the Civil War; but its prominence in iron making and iron working dates from 1874, when the furnace of the Chattanooga Iron Company went into blast. Other furnaces and iron works were immediately established in the same vicinity and as early as 1877 the citizens of Chattanooga boasted that their town was the Pittsburgh of the South.[11] In 1876 a firm of English capitalists belonging to the little corps of moneyed pioneers who invaded the South soon after the Civil War, founded the town of South Pittsburgh on the Tennessee River, where they laid out a model village of comfortable cottages and residences with a city water supply. Their first furnace went into blast in 1879 and that year the people of the state believed that they were entering upon a new era of iron manufacturing. But this particular enterprise languished after the death of its promoters.[12] By 1880 several hundred coke ovens were in operation in Tennessee and their product was shipped as far as East St. Louis.[13] In 1885 there were 9 furnaces in Chattanooga and its immediate vicinity, in addition to 17 foundries and machine shops.[14] An abundant supply of colored labor, as well as of raw materials, constantly attracted new industries to that city.[15] The Tennessee Coal, Iron and Railroad Company, which was consolidated with another large local enterprise, the Pratt Coal and Iron Company, in 1886, had already become the dominant corporation in this vicinity; and its widening control over ore and coal properties and furnaces tended to concentrate active operations near Chattanooga and Birmingham.[16]

COAL AND IRON IN ALABAMA

The modern development of the northern Alabama coal and ore region began about 1870 with the settlement of Birmingham itself.[17] After many vicissitudes and failures, coke was substituted for charcoal for smelting ore, and the hot blast for the cold blast, and a good coking coal was discovered. Everybody was interested in making the iron industry a success. Real estate speculators, neighboring planters, and the railways saw in this their only promise of eventual prosperity. The story of the critical days in 1876, when the little group of daring investors whose fate and that of the community depended upon making the iron venture successful, were waiting with breathless interest the outcome of experiments with the new fuel,

[11] American Iron and Steel Association, *Bulletin*, VIII, 173, June 4, 1874; VIII, 337, Nov. 12, 1874; XI, 205, Aug. 1, 1877; XI, 257, Oct. 3, 1877.

[12] American Iron and Steel Association, *Bulletin*, X, 197, July 19, 1876; XII, 285, Nov. 27, 1878; XIII, 129, May 31, 1879; XXI, 10, Jan. 19, 1887.

[13] American Iron and Steel Association, *Bulletin*, XIII, 331, Dec. 24 and 31, 1879.

[14] *Manufacturers' Record*, VII, 680, July 11, 1885.

[15] National Association of Wool Manufacturers, *Bulletin*, XVI, 380–381, No. IV, Oct., 1886.

[16] *Industrial South*, VI, 405, Nov. 1886.

[17] King, *The Great South*, 336.

coke, reads like a drama. With the success of those experiments the prosperity of the industry was assured. Even before new furnaces were erected, the daily output of the former charcoal furnaces was doubled.[18]

Before the end of this decade the pioneer coke furnace at Oxmoor was making 75 tons a day at a cost of $11 a ton. After this the construction of new plants followed rapidly, and Alabama's reputation as an iron-making state was soon country wide. During the early eighties new companies and new projects were reported almost daily[19] and large fortunes were made in mining and furnace properties, which were developed in some instances by former Federal army officers. Indeed, for a time the Federal brigadier was almost as prominent in the iron world of the South as the Confederate brigadier was in the political world at Washington.[20] In 1883 the Missouri Furnace Company transferred part of its operations from the St. Louis district to this vicinity,[21] and the following year Sheffield, a new iron town on the Tennessee River in Alabama, was founded.[22]

During this initial iron boom, land speculators promoted furnaces in the South without due attention to the likelihood that they would ever pay a steady profit, mainly with a view to disposing of new city lots. This real estate boom, which reached its climax in the middle eighties, received its quietus during the panic of 1893.[23] The new furnaces, however, were in every respect modern plants, and with the aid of the railways, which quoted low rates of less than $4 a ton to Philadelphia and Chicago, Southern iron was finding a place in Northern markets. To be sure, this iron was sufficiently different from the Bessemer pig made from Superior ores, which constituted by far the larger part of the iron made in this country, and from the so-called neutral irons made from mixed and local ores on the Atlantic seaboard and in Ohio, to limit competition with them. Nevertheless the appearance of Southern metal in Northern markets was, as we have previously remarked, a disquieting phenomenon for the furnace owners of that section.[24]

In 1886, eighteen large modern furnaces were under construction in the Birmingham-Chattanooga district. Nine of these were at or near Birmingham itself, 5 were at the new town of Sheffield, 3 at South Pittsburgh, and 1 at Chattanooga.[25] With this rapid increase of plants there was a natural

[18] Armes, *The Story of Coal and Iron in Alabama*, 257–260; American Iron and Steel Association, *Bulletin*, x, 117, Apr. 12, 1876; xi, 257, Oct. 3, 1877.

[19] American Iron and Steel Association, *Bulletin*, xiii, 225, Sept. 10, 1879; xiv, 69, Mar. 17, 1880; xiv, 99, Apr. 21 and 28, 1880; xiv, 181, July 21 and 28, 1880; xv, 147, June 15, 1881; xv, 317, Dec. 14, 1881.

[20] *Cf.* American Iron and Steel Association, *Bulletin*, xv, 147, June 15, 1881; xvi, 290, Nov. 1, 1882; xx, 345, Dec. 29, 1886.

[21] American Iron and Steel Association, *Bulletin*, xvii, 261, Sept. 19, 1883.

[22] American Iron and Steel Association, *Bulletin*, xviii, 129, May 21, 1884.

[23] *E.g.* American Iron and Steel Association, *Bulletin*, xix, 117, May 6, 1885; xxvii, 99, Apr. 5, 1893; *Manufacturers' Record*, lxvi, 55–57, Nov. 5, 1914.

[24] American Iron and Steel Association, *Bulletin*, xix, 27, Jan. 28, 1885; xix, 57, Mar. 4, 1885.

[25] American Iron and Steel Association, *Bulletin*, xx, 345, Dec. 29, 1886.

tendency to centralize control, and the industrial records of the period abound with announcements of consolidations and absorptions of existing enterprises.[26] According to a report in November 1886, 10 furnaces were in blast at Birmingham, making 815 tons of pigs a day, and 10 furnaces were under construction in that vicinity with an aggregate capacity of 1,200 tons a day.[27]

Within a little more than a decade a large industrial capital, the outgrowth to no small extent of initial investments from the North, had been built up in the Southern iron area. Between 1880 and 1890 the amount invested in blast furnaces alone in Alabama increased from $2,700,000 to $15,700,000—a far higher ratio of growth than in any other state except Illinois, and a larger absolute growth than in any other state except Pennsylvania.[28] By 1887, eleven years after coke smelting was introduced in that city, Birmingham iron sales were reported to be $12,500,000 annually[29] and development was proceeding on an imposing scale. The four furnaces built near Birmingham, in 1886, by the Tennessee Coal, Iron and Railway Company, were the largest group ever erected simultaneously in the United States, their aggregate capacity being 720 tons of iron a day.[30]

In 1889 the Southern Iron Company was organized to take over several charcoal furnaces in Tennessee and Alabama as well as the Cranberry ore beds of North Carolina. Altogether this Company owned 8 furnaces and had another under construction, and its immediate object was to make Bessemer steel "by either the acid or the basic process."[31] The same year the De Bardeleben Coal and Iron Company was organized with a capital of $10,000,000. It controlled 7 blast furnaces with a daily capacity of 800 tons of pigs, 7 coal mines, 7 ore mines, 900 coke ovens, besides 25 miles of railroad, quarries and a large amount of residential real estate. The town of Bessemer, a suburb of Birmingham, had arisen almost in a night, although in the vicinity of older furnaces. It produced 250,000 tons of pig iron annually, while the state's entire output a decade before had been but 77,000 tons.[32]

After 1890 a sudden drop occurred in furnace construction. Between 1887 and that date the number of active stacks in the state had risen from 24 to 48. The following year only 9 furnaces were completed and not a single new one was under construction. Yet these furnaces were all in blast with three exceptions, two being shut down for repairs. In the Anniston district east of Birmingham, where charcoal was still the principal

[26] *E.g.*, American Iron and Steel Association, *Bulletin*, XVIII, 65, Mar. 12, 1884; XX, 61, Mar. 3 and 10, 1886; XXI, 41, May 25, 1887.
[27] *Industrial South*, VI, 413, Nov. 9, 1886.
[28] Eleventh Census, *Report on Manufactures, Selected Industries*, 395–396.
[29] *Manufacturers' Record*, XII, 823, Dec. 17, 1887.
[30] American Iron and Steel Association, *Bulletin*, XX, 299, Nov. 17, 1886.
[31] American Iron and Steel Association, *Bulletin*, XXIII, 273, Oct. 2, 1889; XXIII, 332, Dec. 4, 1889.
[32] *Commercial and Financial Chronicle*, L, 523, 525, Apr. 12, 1890.

fuel, there were 16 furnaces, 5 of which were idle.[33] The growth in output had been much more rapid than the growth in plants. Furnaces which five or six years previously had a maximum product of 90 tons a day, were making regularly 150 tons of better iron in 1893.[34]

MARKETS AND COST OF PRODUCTION

Markets for Southern foundry iron were less affected by certain phases of industrial depression than were those for the Bessemer pigs made in the North. Railways were still the largest consumers of iron and steel, and a sudden decline in the demand for steel rails was one of the first phenomena attending panics. Consequently the crisis of 1893 shut-down furnaces first in the North, though it ultimately closed many in the South.

Beginning with the revival of the iron trade in 1878 and 1879 the cost of making pig iron in the South became a subject of debate, and competition between Northern and Southern furnaces was as much discussed as the competition between Northern and Southern cotton mills. Indeed, it was as if the old sectional sentiment which survived from the days of slavery had changed its channel of expression from the political to the industrial field. Undoubtedly some Southerners would have felt that it was sweet revenge to defeat their former foes north of the Ohio and Potomac with their own weapons—the spindle, the furnace and the forge hammer. During the depression following the panic of 1873 prices of ore and fuel, and probably the cost of labor, decreased materially in Southern furnace districts. This was due in no small part to improved local transportation and to the development of new sources of supply. Between 1874 and 1878 the price of coke at Chattanooga declined by one half and the cost of ores decreased.[35] During the early eighties the substitution of coke for charcoal—or better said, the expansion of the coke-iron industry in the South—went on apace. Coke furnaces were larger and could produce more cheaply than the charcoal furnaces which antedated them and several of which still continued in operation. In 1880, 200 coke ovens were working at Tracy City, Tennessee, and 200 were in course of erection. Ovens were also projected or under construction at other points.[36] Coke was shipped occasionally from Southern plants as far north as Indiana and Missouri. Furnace practice was improving and in 1882 Southern iron masters boasted that some of their furnaces equaled the better records in England 5 years before.[37]

With this cheapening and improving of materials, and with better furnace construction and practice, costs were lowered to a point where iron could probably be produced as cheaply in the South as anywhere in the world.

[33] Eleventh Census, *Report on Manufactures, Selected Industries*, 400; American Iron and Steel Association, *Bulletin*, XVI, 50, Feb. 24, 1892; XVI, 90, Apr. 6, 1892.
[34] *Mineral Industry*, II, 376.
[35] American Iron and Steel Association, *Bulletin*, XII, 137, June 12, 1878.
[36] American Iron and Steel Association, *Bulletin*, XIV, 84, Apr. 7, 1880.
[37] American Iron and Steel Association, *Bulletin*, XVI, 178, July 5, 1882.

In 1883, No. 1 foundry pig were made at Virginia furnaces for $10.50 a ton. Perhaps this would be a high average for the costs in Tennessee and Alabama.[38] It was mainly because Virginia, Tennessee and Alabama benefited so largely by the substitution of coke for charcoal as a smelting fuel, that the iron industry in those states was confined within narrow territorial bounds.[39]

SOME SOUTHERN HANDICAPS

In 1886 the South made over 875,000 tons of pig iron, a figure attained but once by the whole country prior to the Civil War.[40] By this time furnace construction was temporarily outrunning the supply of local coal and some gloomy foreboders fancied that the iron industry of the South had seen its best days. The fault lay with incompetent or over-optimistic furnace promoters, who built works before they knew where they would procure the materials with which to run them. A contemporary observer wrote in 1887:

> "We know of an instance where a plant of not less than three first-class stacks is going up, and the Company has not a particle of assurance that it will be able to buy in the market enough coke in five years to blow one of its stacks a month, and it is making no preparation to manufacture coke of its own."[41]

This was one of the cases where furnace promoting and real estate speculating went hand in hand. The South was dazzled by the wonderful success of Birmingham, which had grown from nothing to an industrial city of first importance within a decade.

Besides this unfortunate tendency to tie up the iron industry with outside interests, some Southern iron masters were slow to surrender their ancient prejudices. Not only did the substitution of mineral fuel for charcoal encounter their conservative resistance, but even the adoption of the puddling furnace and rolling mill in place of the bloomery fire and the refinery forge, which had occurred in the North almost 50 years before, was only beginning in the South at the time of the Civil War and made little progress in that section until after the panic of 1873. Last of all, the marvelously rapid growth of steel making in the North, which the South was not prepared to imitate, partly because its iron ores did not make good Bessemer pig and partly because the establishment of this new industry required capital and skill which that section did not yet possess, added a new and serious handicap to competition with the North.[42] Before the end of the eighties, however, the progressive spirit had won the upper hand, and the introduction of mineral fuel had been accomplished. Of the 109 furnaces south of the Mason and Dixon line in 1888, 57 used coke and 52 used char-

[38] *Railroad Gazette*, XV, 286, May 4, 1883.
[39] American Iron and Steel Association, *Bulletin*, XX, 229, Sept. 1, 1886.
[40] American Iron and Steel Association, *Bulletin*, XXI, 211, Aug. 3 and 10, 1887.
[41] *Chattanooga Tradesman*, June 15, 1887, quoted in American Iron and Steel Association, *Bulletin*, XXI, 169, June 29, 1887; *cf. Engineering Magazine*, IV, 858–863, Mar. 1893.
[42] American Iron and Steel Association, *Bulletin*, XXI, 188, July 13, 1887.

coal; but the coke furnaces were new and modern and their aggregate capacity was relatively much larger than that of the older charcoal plants.

Closely associated with the rapid plant development that occurred at this time was the exploration and proving of the South's coal and ore resources. The latter were abundant, though as we have said only one or two deposits of moderate extent, all in North Carolina, were suitable for making Bessemer pig for the acid process, the method then commonly employed in America. Basic Bessemer ores were more plentiful, but obstacles, partly legal and partly economic, prevented the early introduction of a process by which they could be utilized. Coking coal was not as generally distributed as iron ore, and much of it was not of the best quality. Nevertheless, the extension of railways and the lowering of transportation costs rendered available more distant supplies of this fuel, especially from the Pocahontas field.

On the whole the South was making good the prediction of Sir Lowthian Bell, in 1874, that the low cost of assembling raw materials in that section, especially Alabama, was destined to make it one of the cheapest iron-producing regions in the world. The opinion of so high an authority caused several of his fellow countrymen to acquire coal and iron lands in this part of the country, and gave birth to the Southern States Coal, Iron, and Land Company, Ltd., which founded the town of New Pittsburgh and began the erection of the furnaces already mentioned at that point.[43] Northern capitalists, following the early influx of ex-officer pioneers, likewise acquired properties and erected furnaces in the South or invested in established enterprises in that region.[44] But many of the leading men in the industry were Southerners. Perhaps the most prominent of them all was H. F. De Bardeleben, who became a multimillionaire and who was largely responsible for the first great successes in the Birmingham district. Dr. H. M. Caldwell, the president of the company which virtually made Birmingham a great iron center, Colonel E. W. Cole, president of another large company at Sheffield, and indeed most of the men prominent in an official capacity or as plant managers in this region, were also Southern born.[45]

PRICES AND COMPETITION

At a comparatively early date Southern charcoal iron was shipped from the furnaces of northern Georgia and Alabama to Great Britain. As previously mentioned, Southern pigs were occasionally used to ballast a cotton cargo across the Atlantic, as they still are used to ballast cotton cargoes to Japan. But about 1874 these exports received a temporary stimulus, alleged to be the indirect result of the introduction of Pullman sleeping cars upon the British railways. American locomotives and railway cars, as is generally known, developed along lines peculiar to this country. In

[43] American Iron and Steel Association, *Bulletin*, IX, 212, July 16, 1873; X, 345, Dec. 27, 1876; *cf.* XVII, 115, May 2, 1883.

[44] *Cf. Manufacturers' Record*, VI, 615, Dec. 27, 1884; VIII, 249, June 3, 1886.

[45] American Iron and Steel Association, *Bulletin*, XXI, 267, Sept. 28, 1887.

Great Britain wrought-iron car wheels were used, it being supposed that cast-iron wheels, such as were employed in America, would not stand the work required of them on the hard ballasted and fast-traveled foreign roads. But the experiment with Pullman cars disproved this assumption, with the result that cast-iron car wheels were introduced to some extent on the British lines, and American charcoal iron either was, or was supposed to be, the best in the world for this purpose. So in 1874 and 1875 considerable shipments were made to Great Britain, where Alabama and Georgia charcoal pig commanded 7 pounds sterling or more a ton.[46]

Nevertheless the principal market open to Southern iron makers, after supplying their local foundry and rolling mill demands, was in the North. By 1875 pig iron was already passing through Chattanooga for Northern and Western markets.[47] During the next five years Southern coke pig continued to go North in small and irregular quantities. This was a period of extreme depression in the iron business and the movement was checked with the revival of 1879, when the local market again became active. Another era of low prices in 1884 induced Southern furnace men to try once more for a share of the Northern trade. Prior to that little if any Southern pig metal had been sold east of the Alleghenies. This year, however, shipments were made via Norfolk and Savannah to New York and Boston. The successful entry of this market was due not only to the low cost of production in the South but also to the extremely low freight rates offered by rail and water lines.[48] No. 1 Southern coke iron suitable for puddling was quoted at $16 a ton in Philadelphia. It sold at the furnace for about $13. Eastern furnace men promptly cut their prices by some 10 per cent to meet this competition, but Northern founders and mill managers liked the Southern iron and perhaps were not unwilling to encourage a competitor of the local furnaces to remain in the market. A contemporary study of the cost of iron making at eleven representative Southern furnaces in Virginia, Tennessee, Alabama and Georgia, made the average $12.08 a ton, at which rate it could be delivered at a profit, plus freights, in Cincinnati and St. Louis for $15.25 a ton, and in New York for $17.25 a ton. Only certain qualities of Southern iron were suitable for Northern consumption, but the best foundry irons from this section sometimes commanded a premium over those of Northern furnaces.[49] During 1884 over 20,000 tons of Southern iron were sold in Philadelphia and more than 76,000 tons were shipped to various points in New England. Savannah found the trans-shipment of pig iron from railways to coastal vessels a factor of growing importance in its port business.[50]

[46] American Iron and Steel Association, *Secretary's Report for 1875*, 38; *id.*, *Bulletin*, IX, 140, May 14, 1875.

[47] American Iron and Steel Association, *Bulletin*, IX, 380, Dec. 24, 1875.

[48] American Iron and Steel Association, *Bulletin*, XVII, 179, July 4, 1883; XVIII, 210, Aug. 20, 1884; XVIII, 309, Nov. 26, 1884; XVIII, 321, Dec. 17, 1884; XIX, 301, Nov. 11, 1885; XXVII, 43, Feb. 8, 1893.

[49] American Iron and Steel Association, *Bulletin*, XVIII, 163, June 25, 1884.

[50] American Iron and Steel Association, *Bulletin*, XXII, 13, Jan. 11, 1888.

Southern irons competed severely with those smelted in the Mahoning Valley. Presumably this was one reason why the railways supplying furnaces in the latter district reduced their rates in 1885 on ore, coke and limestone. Northern furnace owners not only suffered the disadvantage of paying for a longer haul upon their raw materials, but the cost of those materials included middlemen's profits—to mine owners in the Lake Superior region and elsewhere, to ore commission men and to coal and coke "barons"—while in the South the furnace proprietor often owned his sources of supply for ore and coke and limestone.[51] In the South, moreover, furnace companies had certain subsidiary ways of increasing their earnings, which while not entirely absent in the North were probably less remunerative in that section. In particular they often made a considerable profit out of house rentals and store sales to their employes.[52]

In 1885 there was a slight decline in the quantity of pig iron shipped North from Southern furnaces, but this was followed by a gain in 1886 when 25 Southern works sold about 140,000 tons of pigs to Northern buyers. More than half of this, however, came from Virginia. Eight furnaces in that state sold 82,000 tons in the North while 13 furnaces in Alabama and Tennessee sold 47,000 tons in the same district.[53] Northern iron masters felt, however, in spite of an undercurrent of alarm at the progress of their Southern rivals, that the limit to this competition would be reached long before they themselves were put out of business; and by 1892 it was recognized that, relatively to the North's total consumption, sales of Southern pigs in that section were on the decline. On the other hand that year they began to enter the California market which, though limited, was one of large future promise.[54]

In 1894, Alabama and Tennessee produced about 805,000 tons of pig iron, or nearly 38 per cent of the entire consumption of the United States apart from what was used for making steel—certainly a very considerable proportion of the pig iron converted into castings and various forms of wrought iron in foundries, forges and puddling furnaces. During the six years following 1888 the number of states in which the Tennessee Coal, Iron, and Railroad Company sold pig iron increased from 30 to 39, in addition to which it won a small market in Canada and Mexico, and even made trifling shipments to Europe. During these 6 years the total sales of this Company rose from 225,000 tons to 573,000 tons, marketed principally in Ohio, the other Ohio Valley states, New York and New Jersey. It is notable, however, that within this comparatively brief period the sales of this company's pig iron to dealers and manufacturers in the state of Alabama also increased nearly sixfold.[55]

[51] American Iron and Steel Association, *Bulletin*, XIX, 81, Apr. 1, 1885; *cf. id.*, XXII, 221 July 11 and 18, 1888; *Manufacturers' Record*, XVIII, 8, Jan. 31, 1891; XIX, 9, Feb. 21, 1891.

[52] American Iron and Steel Association, *Bulletin*, XXIII, 171, June 26, 1879.

[53] *Bradstreets*, XIV, 402, Dec. 25, 1886.

[54] American Iron and Steel Association, *Bulletin*, XXVI, 82, Mar. 23 and 30, 1892.

[55] American Iron and Steel Association, *Bulletin*, XXX, 45, Feb. 20, 1896.

CHAPTER XX

IRON MAKING

Furnace Statistics Interpreted, 221. Pig-Iron Production during the Post-Panic Depression, 223. Fluctuating Outputs, 224. General Expansion, 225. Pre-Panic Conditions, 228.

FURNACE STATISTICS INTERPRETED

Furnace statistics constitute a chapter by themselves in the record of the American iron industry's rapid changes during the last four decades of the century. Judged merely by the number in blast in 1873 and 1893 respectively, the industry would have seemed on the decline; for the active establishments fell from 657 to 521 during that interval. Judged by the proportion of furnaces usually idle, the industry would appear to have been chronically depressed and at times on the highway to extinction. Indeed, it might almost be rated the exception for half of the works in condition to make iron to be in operation simultaneously. During the ten years ending with 1883 the percentage of active furnaces never reached 64 per cent and sometimes fell as low as 30 per cent.[1] In 1876 when the full effect of the panic of 1873 was felt, 236 furnaces were in blast and 476 idle. In 1892, however, just before the panic of 1893 when the industry as a whole was rated prosperous, there were but 253 furnaces in operation and 311 were shut-down. Therefore, the prosperity or depression, the growth or the stagnation of the iron industry could not be gaged by furnace statistics.[2]

It is hardly necessary to say that the falling off in the number of furnaces did not imply a decrease in furnace capacity. In 1876, for instance, the average furnace in the United States was capable of making something less than 7,000 tons of iron annually. Twenty years later average annual capacity had risen to more than 37,000 tons.[3] During the constant struggle for the survival of the fittest that the high-furnace mortality of this period records, two principal eliminating causes were at work—location and equipment. In 1893 a single firm in Philadelphia wrecked 7 blast furnaces, of which 5 were in the immediate vicinity of Baltimore, yet none of these furnaces was as old by many years as others that continued in successful operation. Of 13 furnaces in this district wrecked about this time, 11 used mineral fuel and presumably were not discontinued because of its scarcity, as were many charcoal furnaces. The same year a number of furnaces in northern New York were permanently abandoned; but several of these had

[1] American Iron and Steel Association, *Bulletin*, XVIII, 226, Sept. 3 and 10, 1884.
[2] American Iron and Steel Association, *Bulletin*, XLV, 51, June 1, 1911.
[3] American Iron and Steel Association, *Bulletin*, XXX, 52, Mar. 1, 1896.

practically ceased operations prior to this. Simultaneously the leading iron company of Missouri dismantled its coke furnaces south of St. Louis, its charcoal furnace at Pilot Knob, and its Bessemer steel plant at the former of these points. In this case and in the case of the furnaces near Baltimore, the immediate reason for abandoning the plants was an uneconomical location.[4] Indeed, of the two causes mentioned this was relatively the more important, for a plant dismantled solely because it was out of date was frequently replaced by a more modern one.

Since the relative number of charcoal, anthracite and bituminous or coke furnaces was changing, the survival of plants was conditioned to some extent by the kind of fuel they used. The number of furnaces in operation at different seasons was also influenced by the same cause. Under normal circumstances anthracite and bituminous coal and coke furnaces continued in blast throughout the year, except for intervals devoted to making repairs and replacements; but it was customary for charcoal furnaces to blow out in the spring as soon as their winter's supply of fuel was exhausted, and generally they did not resume operation until the following autumn.[5] Possibly this custom was due in part to tradition. Colonial furnaces, which used charcoal exclusively, usually shut-down during the hot season. Years when there was a large demand for new railway equipment, whether or not it were a period of extensive railway building, were likely to be prosperous for charcoal-iron makers, whose product was used for car wheels, even though furnaces using mineral fuel did not share in this activity.[6]

While the tendency to build furnaces of larger capacity was universal, it was more strongly marked in plants using coke than in those using either anthracite or charcoal. The increase in coke furnaces was also greater than the increase in charcoal or anthracite furnaces, and we shall see later that the quantity of pig iron made with coke and bituminous coal increased both absolutely and relatively faster than the quantity of iron produced with anthracite or charcoal. In 1874 there were in the United States 206 charcoal furnaces, 287 anthracite furnaces and 181 furnaces using bituminous coal or coke; the corresponding figures in 1892 were 138 charcoal furnaces, 164 anthracite furnaces and 267 furnaces using coke or bituminous coal. The change in the relative capacity of the furnaces using these three kinds of fuel was even greater than these figures would imply. As this period drew to the close, a principal feature in the production of pig iron was the decline in the output of anthracite iron and the growing output of coke iron. Of the new furnaces recorded in the 1892 Directory of the American Iron and Steel Association, one used anthracite, 16 charcoal, and 35 coke. Of the 58 furnaces abandoned or torn down since the last pre-

[4] American Iron and Steel Association, *Bulletin*, XXVII, 156, May 24, 1893; XVII, 220, July 26, 1893.

[5] American Iron and Steel Association, *Bulletin*, XVIII, 226, Sept. 2 and 10, 1884.

[6] *E.g.*, American Iron and Steel Association, *Bulletin*, XV, 20, Jan. 19 and 26, 1881.

vious issue of the Directory, 22 were anthracite, 14 were coke, and 22 were charcoal.[7]

PIG-IRON PRODUCTION DURING THE POST-PANIC DEPRESSION

Turning now to figures of production,[8] when the period we are now discussing opened, there was every inducement for furnace owners to make all the iron that was possible, for prices were high and the demand was constant. During the summer of 1873, however, it became evident that production was outrunning consumption and on June 19 a meeting of pig-iron makers was held at Cleveland which resolved in favor of a general curtailment of output. It is doubtful whether this meeting, which is interesting mainly as showing the sentiment of the trade, would have accomplished much in the way of restriction had not the panic come to reinforce its action. At least efforts made subsequently that year, and again early in 1874, to agree upon a plan for cutting down production pro rata throughout the country proved fruitless. Indeed, new modern furnaces of large capacity which could produce at low cost were making a reasonable profit while their less-favored competitors were losing money. So the total amount of pig iron made in 1874, in round numbers 2,690,000 tons, was less than 179,000 tons under the record production of the previous year. But furnace men and their agents held nearly 800,000 tons of unsold iron at the end of the season, and including the quantity in the hands of speculators and creditors, the total quantity carried over was estimated at 1,000,000 tons. Holdings of charcoal iron were unusually heavy throughout the country.[9]

In 1875 and 1876 a progressive decline occurred in the quantity of pig iron made, accompanied by a corresponding shrinkage in the stocks of unsold iron carried over into each subsequent season. In 1877, however, there was a gain of 221,000 tons over the output of the previous year and consumption exceeded production, the stocks carried over decreasing by 44,000 tons. The larger use of iron appears to have been in foundries and

[7] American Iron and Steel Association, *Bulletin*, x, 268, Oct. 4 and 11, 1876; xxvi, 50, Feb. 24, 1892.

[8] A great variety of practice has prevailed in the United States in calculating the weight of iron. At the meeting of the American Iron and Steel Association held in Chicago in 1865 a resolution was adopted requiring the short or net ton of 2,000 pounds to be employed in all the Association's statistics. Beginning with 1893, however, the Association published its figures of domestic production in gross tons of 2,240 pounds. The United States Census uses the short ton of 2,000 pounds. The long ton used by the Treasury Department in reckoning imports and exports was 2,240 pounds. Moreover the Treasury statistics of valuation, in the days when gold was at a premium, were in gold in the case of imported iron and in currency in the case of exported iron. In 1881 the United States Association of Charcoal Iron Workers adopted a resolution to make 2,000 pounds the standard ton in the transactions of its members. In private contracts, however, the practice still varied widely. Bar iron was measured in tons of 2,260 pounds, pig iron cast in sand in tons of 2,268 pounds, and charcoal-iron blooms in tons of 2,464 pounds, while local furnace men added individual variations to these figures. *Cf.* American Iron and Steel Association, *Bulletin*, xv, 268, Oct. 19 and 26, 1881.

[9] American Iron and Steel Association, *Bulletin*, ix, 164, June 4, 1875.

machine shops, as fewer rails were made than the previous year and there was practically no addition to the output of rolled iron.[10]

FLUCTUATING OUTPUT

The recovery which began in 1877 continued slowly throughout the ensuing year, though production was still considerably below that of the early seventies. In 1879, however, our furnaces made more than 3,000,000 tons of pigs, thus establishing a new record. This was remarkably exceeded in 1880 when our pig-iron output reached 4,295,000 tons, a leap forward of 40 per cent within a year. The country was now making 50 per cent more iron than during the boom of 1872 and 1873, and the production of charcoal iron kept pace relatively with that of anthracite, bituminous and coke iron. In fact it slightly exceeded the latter in percentage.[11] During the years which immediately followed, furnace output continued to expand, but at a more moderate rate. Instead of increases of 40 per cent, the ratio of growth fell to 8 per cent during the following year and 11 per cent between 1881 and 1882. These increments were fairly well distributed among bituminous, coke, anthracite and charcoal iron, although by the close of the season bituminous and charcoal pigs had begun to accumulate in the hands of producers. Imports of foreign pig iron in 1882 were about 540,000 tons, or slightly more than 10 per cent of domestic production. At this time the Lehigh Valley was our greatest furnace center, with an output of more than 600,000 tons per annum. Allegheny County, which a decade later was to lead the country in iron production, at this time made but 359,000 tons.[12]

In 1883 the period of expansion which had begun four years before came to a close and a slight decrease of output was recorded as compared with the previous season. Production had gained such an impetus during this period of active demand, however, that it proved difficult to halt expansion when the market exhibited symptoms of stagnation. Toward the close of 1882 railroad building, which had been pushed forward eagerly for several years, was suddenly checked and other reactionary influences co-operated with this setback to lessen the demand for iron and steel. In fact for the first time in the history of that industry in America the output of even Bessemer steel decreased. The decline in pig-iron production was even more marked the following year, when there was a falling off in product of 557,000 tons, or 11 per cent.[13] In spite of this some states, notably Illinois and Alabama, increased their output, the former by 38 per cent. The heaviest falling off was in the production of charcoal pig iron, which declined 20 per cent throughout the country. The western movement of

[10] American Iron and Steel Association, *Bulletin*, XII, 84, Apr. 10, 1878.
[11] American Iron and Steel Association, *Bulletin*, XV, 52, Feb. 23, 1881.
[12] American Iron and Steel Association, *Bulletin*, XVII, 44, Feb. 14, 1883; XVII, 77, Mar. 14 and 21, 1883.
[13] American Iron and Steel Association, *Bulletin* XVII, 197, July 18 and 25, 1883; *Commercial and Financial Chronicle*, XXXVIII, 147–148, Feb. 2, 1884.

the iron industry was indicated by the fact that production was actually expanding west of the Alleghenies at a time when it was contracting in the East. This change did not affect the supremacy of Pennsylvania as an iron-making state, however, because the growth of the industry at Pittsburgh fully compensated for the slower rate of progress east of the mountains.[14]

This decline continued into 1885, but was checked in the latter half of the year so that the decrease in output was less than 60,000 tons; but the total falling off since the record year of 1882 was in round numbers 648,000 tons. This season closed with prospects favorable for a turn in the tide of production the following season. Already Allegheny County, with an output of nearly 586,000 tons, outranked the Lehigh Valley or any other furnace center in the Union. Between 1882 and 1885 the quantity of iron made in New England had declined by more than half, and Vermont had ceased to be an iron-making state. The ratio of decrease was even greater in New York, New Jersey and Maryland; and Pennsylvania as a whole barely held its own. On the other hand decided percentage increases occurred in Virginia and Alabama. The quantity of iron made in the Rocky Mountain and Pacific states and territories declined during these four years from 31,000 to 11,000 tons.[15]

GENERAL EXPANSION

Next year the tide turned again, as it had in 1880, with a leap forward in production of 40 per cent to a total of 6,367,000 tons. A large part of this increase was credited to Pennsylvania and Illinois, and was due to the revival of railway building and other activities calling for Bessemer steel and therefore for the Bessemer pigs which the giant furnaces of these states produced. Recovery was slower in the South, and the growth of output in that section was but moderate during the early years of the revival which now began.[16]

This revival was world-wide but came earlier in America than abroad. Already our iron makers were looking forward to the day when the output of their furnaces would exceed the total even of Great Britain, which hitherto had outranked all other countries in this industry. America's pig-iron output, which was considerably less than one-third that of Great Britain in 1870, approached half that of the older country in 1880, and by 1890 was rapidly overtaking it. Since nearly half of the pig iron made in British furnaces was exported, while practically all of that made in American furnaces was consumed at home, we presumably used more iron than any other nation. This great expansion was made possible by the growing use

[14] American Iron and Steel Association, *Bulletin*, XVIII, 171, July 2 and 9 1884; XIX, 37, Feb. 4 and 11, 1885.

[15] American Iron and Steel Association, *Bulletin*, XX, 21, Jan. 20 and 27, 1886; XX, 29, Feb. 3, 1886.

[16] American Iron and Steel Association, *Bulletin*, XXI, 20, Jan. 26, 1887.

of coke—which came mostly from west of the Alleghenies—and by the increasing utilization of the new supplies of ore in the Lake Superior region and the South. Naturally, therefore, the center of the industry continued to move westward. Less iron was now made with anthracite coal alone than with charcoal alone, our so-called anthracite pigs being smelted for the most part with a mixture of that coal and coke. In fact no anthracite was used outside of the four states, New York, New Jersey, Maryland and Pennsylvania. Although the South was making steady progress in iron production, in 1886 the nine Southern states together smelted but 877,000 tons, while Ohio, which ranked second in this industry, produced 908,000 tons, and Pennsylvania 3,293,000 tons.[17]

Comparing the amount of iron made in different sections of the country in this critical year with the amount made thirty years before, we discover that there had been a slight decline in New England—from 34,000 to 33,000 tons—but an increase in every other group of states. In New York, New Jersey and Pennsylvania, and in the South, the output had multiplied sixfold; in the West it had increased more than sixteen fold. But while the production of pig iron had risen during these three decades from 912,000 to 9,365,000 tons, the product of our bloomeries had declined from 92,000 to 42,000 tons. About 43 per cent of the pig iron made in this country in the later eighties was graded as Bessemer.[18]

In 1887 a slight reaction was recorded, due in part to the enforced curtailment of production on account of a strike in the Connellsville coke district and later to a strike in the Alabama coal fields. The latter difficulty aggravated an existing embarassment, for the Alabama furnaces were already hampered by lack of coke. But the latter half of the year witnessed a prompt recovery, so that the total output for 1887 was 6,417,000 tons, an increase of 13 per cent over the previous season. Allegheny County produced almost 900,000 tons, easily outranking the Lehigh Valley, although the later eclipsed all previous records by making 723,000 tons.[19]

A diminution in the demand for iron and steel for railroad purposes, accompanied with a decline in prices, made itself felt during the early months of 1888. But the growing demand for iron and steel for structural purposes and other uses tended to maintain the market and to encourage furnaces to keep in operation. A fall in price of foundry irons occurred, partly because the largest and best-equipped furnaces, which had been devoted mainly to making Bessemer pigs, changed to the former as soon as the demand of the steel makers declined, and these giant-establishments were able to compete at an advantage with the smaller and scattered furnaces which had hitherto devoted themselves to mill and foundry iron.

[17] *Commercial and Financial Chronicle*, XLIV, 163–165, Feb. 5, 1887.

[18] American Iron and Steel Association, *Bulletin*, XXI, 125, May 11, 1885; XXI, 204, July 27, 1887.

[19] American Iron and Steel Association, *Bulletin*, XXI, 196, July 20, 1887; *Commercial and Financial Chronicle*, XLV, 105, July 23, 1887.

Consequently although the output of steel rails fell off 824,000 tons, there was a small increase in the quantity of pigs produced. This was accounted for partly by lower importations, but was even more largely due to the wider uses to which iron and steel were being put as a result of technical progress. It was estimated that the quantity of Bessemer steel employed for miscellaneous purposes in 1888 was nearly five times the amount used five years before, and nearly double the amount used two years previously. The rapid expansion of the industry at this period is measured by the jump from an output of 4,530,000 tons of pigs in 1885 to 7,270,000 tons three years later.[20]

This period of rapid expansion in output continued through the following two seasons. During the first six months of 1889 more pig iron was made in the United States than during the entire year of 1879. By far the greater part of this increase was in iron smelted with coke or bituminous coal. Production was stimulated by an active demand at low prices, the growth of consumption being due in part to the wider use of iron and steel on account of their cheapness. The substitution of steel for iron in many fields where the latter had been mainly or exclusively employed tended to lessen slightly the volume of pig consumption, because a given quantity of pig iron converted into steel would in most cases serve the purpose of a larger quantity of pig iron converted into castings or rolling-mill products. For instance Sir Lowthian Bell estimated that the saving thus made in weight of pig iron used was about 17 per cent in a steel vessel as compared with an iron vessel. An important new field of consumption at this time was in the construction of large buildings; for it was during the late eighties and early nineties that skyscrapers were developed in America.[21]

Pennsylvania's leadership as our greatest iron-producing center remained virtually unaffected by the revolutionary expansion and changes in processes, products and markets which occurred during these years of intense activity. Ohio steadily held its place as our second iron-making state, although by a less secure and a decreasing margin. Meanwhile Alabama and Illinois competed for third place with alternating fortunes. The additions to output at the head of Lake Michigan and in the Birmingham district were phenomenal. During these years also, America was racing neck and neck with Great Britain for primacy in pig-iron production. We have just noted the remarkable change in the relative standing of the two countries resulting from the stationary or declining output of Great Britain, which reached its maximum for this period in the early eighties, and the rapidly advancing output of the United States. Andrew Carnegie, in an interview given at the end of December 1889, explained the boom which the iron and steel industry was then experiencing by the fact that prices

[20] American Iron and Steel Association, *Bulletin*, XXII, 236, Aug. 1, 1888; XXIII, 20, Jan. 23, 1889; *Commercial and Financial Chronicle*, XLVIII, 110–111, Jan. 26, 1889; XLVIII, 717, June 1, 1889.

[21] *Commercial and Financial Chronicle*, XLIX, 98–99, July 27, 1889; L, 159–160, Feb. 1, 1890.

had advanced in Europe so as to prevent foreigners from selling iron in America. It was due to our declining imports that our own manufacturers could keep their works profitably employed, although we built only 7,000 miles of railway in 1889 as compared with 13,000 miles the previous year. Great Britain was still making a little more pig iron than our own country, but we were by this time indisputably the largest consumers of this product. We also outdistanced Great Britain, and had done so since 1887, in the production of steel, rolled iron and steel rails. In fact by 1889 we made about two tons of rails for every ton made in England.[22]

After this banner year, when our iron output reached 8,500,000 tons and our consumption of iron and steel was estimated to exceed 9,360,000 tons, it was natural to expect a reaction. In this, however, our iron makers were happily disappointed. Production increased consistently throughout 1890, and the country made more iron each six months of that year than it had during twelve months five years before. The total output for the census year ending June 30, 1890, was in round numbers 9,580,000 short tons as compared with 3,780,000 ten years previously and 2,053,000 in 1870. The increase during the first of these two decades was 85 per cent, during the second decade it was more than 153 per cent.[23]

So rapid was the expansion of output during this period that Edward Atkinson in a study of the future geography of iron production expressed concern lest a famine in this essential article might not eventually ensue from exhaustion of raw materials. The total production for the calendar year of 1890 was 10,307,000 tons, a figure which placed us definitely ahead of any other country. We had increased our output 40 per cent within two years "at a time when there has been no special activity in the construction of new railway mileage, a sufficient indication of the multiplying uses to which iron and steel were being put."[24]

PRE-PANIC CONDITIONS

But 1890 was destined to remain our banner year in iron production for some time to come. The two seasons immediately preceding the crisis of 1893 and the era of checked industrial prosperity which followed witness a slight decline in annual output. By December 1890, the condition of the iron market was so unpromising that the Shenango and Mahoning Valley furnace owners, some thirty in number, shut down by agreement for six months. A coal strike in Alabama and a more serious strike of coal miners and coke workers in the Connellsville district also curtailed production. In fact the decline during these six months was greater, both absolutely and relatively to total output, than after the panic of 1873. Following that earlier crisis, a falling off of 27 per cent occurred between 1873 and 1876, the year of minimum production. In 1891 a decline of 26

[22] American Iron and Steel Association, *Bulletin*, XXIII, 357, Dec. 25, 1889.
[23] American Iron and Steel Association, *Bulletin*, XXIV, 244, Aug. 27, 1890.
[24] *Commercial and Financial Chronicle*, LII, 185–186, Jan. 31, 1891.

per cent occurred within six months. But this was less indicative of unsound business conditions than of the increasing solidarity of the industry, its sensitiveness of response to economic influences and its efficiency of co-operation, as compared with 18 years before. The setback in 1891 differed from that in 1873 in the fact that the financial stringency of the former period was caused by over-trading in our own country, while the stringency of 1891 was mainly the result of over-speculation and its after effects in foreign countries. In fact a quick recovery occurred during the last half of the year, when production reached a figure never before attained for an equal period in the history of the country. Moreover, the curtailment during the first half of the year resulted in our consumption for the entire season exceeding our production, so that the stock carried over into 1892 was smaller than that carried over twelve months before.[25]

Only 1,366,000 tons of rails were rolled in 1891 as compared with 2,013,000 tons in 1890, indicating that consumption in other fields continued to grow faster than output. Since 1887 our imports of iron and steel and their manufactures had shrunk about two-thirds, or from approximately 2,000,000 tons to 625,000 tons. The decline of output in the first half of 1891 was confined mainly to Pennsylvania and Ohio and did not appreciably affect the South.[26]

More positive evidence appeared in 1892 of the slowing down of the world's prosperity which was to express itself in the crisis of the following year. Great Britain's furnaces had been curtailing their output since 1889, simultaneously with the period of most rapid expansion in America. This was because that country normally exported, mostly in manufactured forms, a large fraction of the iron she produced. These exports declined nearly 70 per cent between 1890 and 1892. On the other hand the iron made in our own country was still consumed at home and, until the depression became general here, there was no appreciable lessening of demand. The South continued to make great strides in output, although Illinois, which made 950,000 long tons of pig iron in 1892, now outranked Alabama, which for two seasons had stood next to Ohio as our third iron-producing state. Pig iron commanded low prices. Grey forge-iron and Bessemer pigs at Pittsburgh dropped respectively to $12.50 and $13.75 a ton. Under such conditions—for our furnaces still continued to operate at a profit—it was quite natural that foreign competitors should be excluded from our markets.[27]

In 1893 the iron industry, in sympathy with all other branches, experienced a period of intense depression. By the close of the year only 137 furnaces were in blast, the smallest number within the memory of a genera-

[25] American Iron and Steel Association, *Bulletin*, XXV, 212, July 22, 1891; XXVI, 20, Jan. 20 and 27, 1892.

[26] *Commercial and Financial Chronicle*, LIV, 184–185, Jan. 30, 1892.

[27] *Commercial and Financial Chronicle*, LV, 393–395, Sept. 10, 1892; LVI, 144–145, Jan. 28, 1893; American Iron and Steel Association, *Bulletin*, XXVII, 28, Jan. 25, 1893.

tion. During the latter half of the year our iron output reached the lowest point since 1885. The only states which maintained their production were Georgia, Maryland and Colorado, all of which were small producers. Illinois' output, which had recently risen above 1,000,000 tons per annum, fell during the last half of 1893 to 69,000 tons. Though Southern furnaces curtailed production, they were for the time being less affected by the panic than those of the North.[28]

America's per capita consumption of iron was estimated by Abraham S. Hewitt to be about 20 pounds per annum in 1867; it approached 400 pounds per annum in 1893. In 1879 the United States used something under 1,000,000 tons of steel rails and about 1,684,000 tons of other iron and steel products. At that time the railroads consumed considerably more than one-third of all the iron and steel used by the nation. Ten years later the country consumed annually about 1,550,000 tons of steel rails and 6,000,000 tons of other iron and steel products. In other words, the proportion of the total iron and steel used which was consumed by the railways, had fallen during this decade from roughly—for all such figures are but approximate—one-third of the total to one-fifth of the total.[29]

[28] *Commercial and Financial Chronicle*, LVIII, 156–158, Jan. 27, 1894; American Iron and Steel Association, *Bulletin*, XXVIII, 21, Jan. 20, 1894.

[29] British Iron Trade Commission, *Report*, 7; American Iron and Steel Association, *Bulletin*, XXIV, 275, Sept. 24, 1890.

CHAPTER XXI

STEEL MAKING

BESSEMER WORKS IN THE EAST

For some years after the Bessemer process was introduced in the United States, the American patents under which makers were licensed to employ it were controlled by a limited number of firms, never exceeding ten altogether. This had some influence upon the geographical distribution as well as upon the expansion of the industry.

New England never became a steel-making section, despite the fact that it was a relatively large steel consumer, because it lacked suitable raw materials. When the Washburn Wire Company, at Worcester, Massachusetts, put in a Bessemer plant in 1884, it was the only establishment of the kind in this group of states, and the Company made its steel, which was employed for rolling rails, almost entirely from English pig.[1] Most works of this kind subsequently erected in New England were parts of larger enterprises that employed the product directly in their own manufactures.[2]

During the depression of 1873 the Troy Works, which shared with the experimental plant at Wyandotte the honor of making the first Bessemer steel produced in America, temporarily suspended operation. They resumed in the autumn of 1874 and the following season were running at full capacity, turning out in some instances over 271 tons of ingots in 24 hours. That year the original works and several affiliated neighboring firms and blast furnaces were consolidated, as the Albany and Rensslaer Iron and Steel Company.[3] Ten years later the successor of this Company erected three modern blast furnaces in South Troy, and the steel works were enlarged with a view to using their entire output of 450 tons a day. Though these furnaces were completed in the course of the next two years and the entire plant was brought up to date, the enterprise was not successful and in 1893 the establishment was sold by receivers.[4]

[1] Washburn, *Industrial Worcester*, 214–216; American Iron and Steel Association, *Bulletin*, XVIII, 157, June 18, 1884; XVIII, 205, Aug. 6 and 13, 1884.

[2] American Iron and Steel Association, *Bulletin*, XIII, 37, Feb. 6, 1889; XXIII, 260, Sept. 18, 1889.

[3] American Iron and Steel Association, *Bulletin*, VIII, 293, Oct. 1, 1874; IX, 9, Jan. 22, 1875; IX, 101, Apr. 9, 1875.

[4] American Iron and Steel Association, *Bulletin*, XIX, 339, Dec. 23, 1885; XXI, 157, June 15, 1887; XXVII, 337, Nov. 22 and 29, 1893.

Of the other early steel works, those of the Cambria Iron Company, which was at the beginning of this period the largest firm in the industry,[5] continued in profitable operation, although they did not keep pace with the growth of some of their competitors. The Pennsylvania Steel Company near Harrisburg continued to pay liberal dividends during the years immediately following the panic of 1873, and increased its output of steel rails even during the darkest days of the depression. In 1875 it put its first blast furnace in operation, and began the construction of another.[6] Twelve years later the Company purchased the tract of land at Sparrow's Point on Chesapeake Bay, six miles from Baltimore, where it erected a large plant to smelt the ores which it, in association with the Bethlehem Iron Company, had acquired in Cuba, thus bringing fuel and ore together at tidewater, much as was being done at the head of Lake transportation in the vicinity of Chicago. Three years were consumed in the erection of the plant and the first steel was made in 1891 at which time three blast furnaces were already producing iron. A year later these works had an annual capacity of 400,000 tons of steel annually, and a shipyard was in operation.[7] The Sparrow's Point plant was nominally owned by the Maryland Steel Company under the control of the Pennsylvania Steel Company, both of which passed into the hands of receivers in 1893. This move, however, was mainly for the purpose of safeguarding the Company's interests and did not involve a discontinuance of operations. During the acute financial stringency which then prevailed, the owners found themselves unable to meet the heavy cash obligations which they had incurred in erecting the Sparrow's Point plant; but a successful reorganization followed almost immediately.[8]

In 1874 the Lackawanna Iron and Coal Company of Scranton, Pennsylvania, began the erection of a two-converter Bessemer plant and a rolling mill for making steel rails, which went into operation in 1875. At that date the Company was employing 113 puddling furnaces in the manufacture of iron rails. Its plant included six blast furnaces, five at Scranton and one in New Jersey.[9]

At the annual meeting of the Bethlehem Iron Company in 1877 the stockholders were informed that the corporation had become part owner of the Bessemer patents in America. This Company had been manufacturing Bessemer steel since 1873. Before 1893 its works had already

[5] American Iron and Steel Association, *Bulletin*, XII, Jan. 12, 1876; "*Works of the Cambria Iron Company*" by A. L. Holley and Lenox Smith, in *Engineering* (London), XXV, 422, May 31, 1878; XXV, 485–487, June 21, 1878; XXVI, 21–24, July 12, 1878; XXVI, 41–42, July 19, 1878; XXVI, 152–153, Aug. 23, 1878; XXVI, 233, Sept. 20, 1878.

[6] American Iron and Steel Association, *Bulletin*, VII, 325, Oct. 29, 1874; IX, 308, Oct. 15, 1875; IX, 316, Oct. 22, 1875.

[7] American Iron and Steel Association, *Bulletin*, XXI, 93, Apr. 6, 1887; XXV, 228, Aug. 5, 1891; XXVI, 45, Feb. 17, 1892.

[8] American Iron and Steel Association, *Bulletin*, XXVII, 124, Apr. 26, 1893; XXVII, 188, June 21, 1893; *Commercial and Financial Chronicle*, LVI, 1015, June 17, 1893.

[9] American Iron and Steel Association, *Bulletin*, VII, 249, Aug. 13, 1874; IX, 341, Nov. 12, 1875.

become among the largest in the world and, as we shall see, they were pioneers in the employment of hydraulic presses for making heavy forgings and casting ingots under compression.[10] Another important Eastern plant was that of the Midvale Company, which supplied large quantities of ordnance steel to the Government.

BESSEMER WORKS WEST OF THE ALLEGHENIES

Turning now to the country west of the Alleghenies, in addition to several relatively small steel-making centers—some of which, like Cleveland, were important producing points—two districts of first rank developed soon after 1870, in the neighborhood respectively of Pittsburgh and of Chicago. Eight Bessemer works were running in the United States in 1875, at Albany, Bethlehem, Harrisburg, Johnstown, Newburg, Chicago and Joliet; and two others, the Lackawanna Works just noted at Scranton and the Edgar Thomson Works near Pittsburgh, were approaching completion.[11] St. Louis as yet made no steel, but was attracting attention, as already mentioned, as a promising blast-furnace center. Sixteen railroads converged at that city, all extending into rapidly developing country where new lines and branches were under construction. Consequently St. Louis was a great rail market, removed from foreign and tidewater competition. In 1875 the Vulcan Iron Company, the largest of several enterprises in this vicinity, began the erection of a Bessemer plant and a steel-rail mill, which did not go into operation, however, until 1876—not a very favorable time for starting such an enterprise, for the country was still in the trough of the depression following the panic three years before. Operation seems to have been interrupted frequently either by financial embarrassment or by lack of orders. In 1881 the consolidation already mentioned in connection with ore smelting at this point was effected. The companies which formed the new combination were the Pilot Knob Company, which furnished ore, the Grand Tower Company, which furnished fuel, and the Vulcan Steel Works, which converted these materials into iron and steel, the whole forming virtually a closed productive organism, controlling all the operations of manufacture from the raw materials to the finished product. More than this, the new amalgamation was backed by a syndicate of stockholders who controlled 14,000 or 15,000 miles of railroad and were presumably able to throw heavy orders in its way. In spite of these advantages the new corporation did not thrive.[12] Other steel works employing both the Bessemer and the open-hearth processes were erected at St. Louis, but they were associated with entirely different lines of manufacture.[13]

[10] American Iron and Steel Association, *Bulletin*, XI, 189, July 11, 1877; XII, 153, July 3, 1878; XX, 161, June 23, 1886; XXIV, 18, Jan. 22, 1890; XXV, 105, Apr. 15, 1891.

[11] American Iron and Steel Association, *Bulletin*, IX, 157, May 28, 1875.

[12] American Iron and Steel Association, *Bulletin*, IX, 149, May 21, 1875; IX, 354, Nov. 26, 1875; X, 219, Aug. 16, 1876; XV, 276, Nov. 2, 1881; XV, 292, Nov. 16, 1881; XV, 323, Dec. 21, 1881; XIX, 237, Sept. 2, 1885.

[13] *E.g.*, American Iron and Steel Association, *Bulletin*, XXVI, 137, May 18, 1892.

THE CARNEGIE COMPANIES

Bessemer steel making did not begin at Pittsburgh until 1875, when the Edgar Thomson Steel Company made its first blow. This was the ninth company to manufacture steel rails in the United States. The Carnegie Brothers, who were already well-known furnace men and iron manufacturers, were among the promoters of the new enterprise. They controlled the Lucy Furnaces with a capacity of 5,000 tons of Bessemer pigs per month, all of which were sold to the Edgar Thomson Steel Works.[14] The future policy of the Carnegies was indicated by a note from Andrew Carnegie in 1876, stating the Lucy Furnaces would render the Edgar Thomson plant "entirely independent of the general market."[15] Two years later these works were already using 8,000 tons of pig iron a month and were preparing to erect additional furnaces of their own.[16] In 1879, when the patents on the Bessemer process expired, a company was organized to erect a second steel plant at Homestead, near Pittsburgh, which went into operation two years later.[17] The same year Carnegie Brothers and Company, Ltd., was organized with a capital of $5,000,000. This firm owned the Lucy Furnaces, the Edgar Thomson Steel Company, the Union Mills in Pittsburgh and extensive coal and ore lands in Pennsylvania.[18] Two years later it took advantage of a temporary depression in the industry to acquire the works at Homestead. The Carnegies promptly discontinued making rails there and devoted the entire capacity of the establishment to steel specialties.[19]

This conversion of the Homestead works to the production of merchant shapes was regarded as a striking indication of the new employments which were being found for steel. The Homestead Works were originally projected for the manufacture of ingots and billets to be used by the crucible steel makers of Pittsburgh who promoted the company; but they were diverted to the manufacture of steel rails before they were finished. Within a couple of years their purpose was again changed, this time to the manufacture of steel shapes to take the place of iron.[20]

By 1887 the iron and steel works owned by Andrew Carnegie and his associates at Pittsburgh were producing at the rate of 550,000 tons of finished products annually. All the pig iron, coke, ferro-manganese and spiegeleisen used in the manufacture of these products was also made by Carnegie companies. A contemporary authority observed:

"There are no other works in the world under one management which have reached this remarkable output or are likely soon to attain it."

[14] Bridge, *Inside History of the Carnegie Steel Company*, 76–79; American Iron and Steel Association, *Bulletin*, IX, 268, Sept. 3, 1875; IX, 273–274, Sept. 10, 1875.

[15] American Iron and Steel Association, *Bulletin*, X, 148, May 17, 1876.

[16] American Iron and Steel Association, *Bulletin*, XII, 243, Oct. 23, 1878.

[17] American Iron and Steel Association, *Bulletin*, XIII, 275, Oct. 29, 1879; XV, 77, Mar. 23 and 30, 1881.

[18] American Iron and Steel Association, *Bulletin*, XV, 89, Apr. 13, 1881.

[19] Bridge, *Inside History of the Carnegie Steel Company*, 85–87, 151–152; American Iron and Steel Association, *Bulletin*, XVII, 301, Oct. 24 and 31, 1883.

[20] Bridge, *Inside History of the Carnegie Steel Company*, 161; American Iron and Steel Association, *Bulletin*, XII, 297, Oct. 24 and 31, 1883.

The Jones and Laughlin Bessemer Works, to make blooms for crucible steel, went into operation in 1886; and in 1889 the Duquesne Works made their first blow.[21] A year later the latter enterprise was purchased by the Carnegie interests. Its plant was modern, equipped to operate with great economy, and would have proved a dangerous rival. By acquiring it, the Carnegie interests obtained almost absolute control of the steel-rail business in the Pittsburgh district.[22] Another twelve months saw the Carnegie interests consolidated into the Carnegie Steel Company. The new organization owned and operated the following plants: the Edgar Thomson Steel Works and blast furnaces, the Duquesne Steel Works, the Homestead Steel Works, the Union Mills, the Beaver Falls Mills, the Lucy Furnaces and the Keystone Bridge Company. Subsidiary to these large constituent companies were coal mines, coke ovens and iron mines. The capital was $25,000,000.[23]

THE ILLINOIS STEEL COMPANY

A somewhat similar process of consolidation, though not so closely associated with the name of a single family, was occurring meanwhile in the Chicago district. It will be recalled that the first steel rail rolled in the United States was made at Chicago from an ingot cast at Wyandotte, at works under the same control as the Chicago rolling mills, and that Bessemer steel was made in Chicago almost immediately thereafter. The North Chicago Rolling Mill Company produced at its own furnaces in 1875—a year of depression—34,000 tons of pig iron. It also made and delivered 36,000 tons of steel and more than 22,000 tons of iron shapes and manufactured iron.[24] In fact throughout this period of slack business the western steel makers seem to have fared better than their eastern rivals. The Company owned works at both Chicago and Milwaukee, and by 1878 had 3,000 men on its payroll and a manufacturing capacity of 1,000 tons of iron and steel a day.[25] In 1880 the number of employes had increased to 5,000 and the annual product of iron and steel had risen from the 60,000 tons reported in 1875, to 374,000 tons, and nearly 100,000 tons were added to this total the following year.[26] In 1882 the North Chicago works operated four blast furnaces and had one more under construction. The molten iron was conveyed in ladles directly from the furnaces to the converters. The same year the interests in control of this corporation began to make steel at a new plant on a more extensive site in South Chicago.

[21] American Iron and Steel Association, *Bulletin*, XIX, 341, Dec. 23, 1885; XXIII, 51, Feb. 20, 1889.

[22] Bridge, *Inside History of the Carnegie Steel Company*, 174–179; American Iron and Steel Association, *Bulletin*, XXIV, 325, Nov. 12, 1890.

[23] American Iron and Steel Association, *Bulletin*, XXVI, 165, June 8, 1892; XXVI, 219, July 27, 1892; XXVI, 341, Nov. 23, 1892.

[24] American Iron and Steel Association, *Bulletin*, X, 43, Feb. 9, 1876.

[25] American Iron and Steel Association, *Bulletin*, XII, 170, July 24 and 31, 1878.

[26] American Iron and Steel Association, *Bulletin*, XIV, 213, Sept. 1, 1880; XV, 205, Aug. 10 and 17, 1881.

Two years later the Company equipped itself to roll merchant shapes as well as rails: and by 1888 the product of all the works it controlled exceeded 1,000,000 tons.[27]

One of the first Bessemer plants in the United States was erected at Joliet. The original company became bankrupt during the crisis of 1873, but was reorganized and resumed operations the following year, and in 1875 its works were making extraordinary runs for that day. Four years later, however, its property was sold under a second mortgage, the change of management apparently not interrupting its operations. The plant was remodeled and enlarged in 1883, and two years later was equipped to produce Bessemer rods, a prophecy of the great steel-wire industry that was to grow up at this point; but for some time after that date the principal product continued to be steel rails.[28]

As early as 1879 Cook County had outdistanced Allegheny County as a Bessemer rail producer, turning out 123,000 tons as compared with 73,000 tons made by its eastern rival. Including the neighboring city of Joliet, the Chicago center made 178,000 tons.[29] When the North Chicago Rolling Mills Company extended its investments to the South Chicago plant, it was obliged to organize a second corporation to handle the new enterprise, in order to evade a limitation in its charter; but the two companies were virtually a single organization controlling the two works in Chicago and the establishment in Milwaukee. Altogether they had double the capacity of any other steel-making establishment in the United States. In an emergency, the North Chicago mills used pig iron produced at the South Chicago works and other reciprocities of this kind were constantly occurring between them.[30] The annual product of the various iron and steel works at the head of Lake Michigan, of which Captain Ward of Detroit was the pioneer, viz., the North Chicago, South Chicago, Union, Calumet and Joliet plants, was valued at about $22,000,000. They employed 10,000 hands and a capital of $10,000,000. The Union Iron and Steel Company, in the same city operated four blast furnaces with an aggregate capacity between 2,000 and 3,000 tons per week and two 12-ton converters.[31] Much stress was laid by admirers of Chicago energy upon the fact that this great industry had been built up upon raw materials brought from distant parts of the country; for the 19 blast furnaces in Chicago used Lake Superior ore and Connellsville coke. There were 11 separate works in this city producing steel, including 5 Bessemer, 2 Roberts-Bessemer, 3 open-hearth, and 1 crucible plant.[32]

[27] American Iron and Steel Association, *Bulletin*, xvi, 19, Jan. 18, 1882; xvi, 109, Apr. 12 and 19, 1882; xvi, 173, June 28, 1882; xviii, 181, July 16, 1884; xxii, 245, Aug. 8, 1888.

[28] American Iron and Steel Association, *Bulletin*, xviii, 292, Oct. 1, 1874; ix, 363, Dec. 3 and 10, 1875; xiii, 149, June 11, 1879; xvii, 349, Dec. 19 and 26, 1883; xix, 41, Feb. 18, 1885; xix, 349, Dec. 30, 1885.

[29] American Iron and Steel Association, *Bulletin*, xiii, 314, Dec. 10, 1879.

[30] American Iron and Steel Association, *Bulletin*, xv, 133, May 25, 1881; xvi, 13, Jan. 11, 1882.

[31] American Iron and Steel Association, *Bulletin*, xvi, 19, Jan. 18, 1882.

[32] American Iron and Steel Association, *Bulletin*, xxiii, 84, Mar. 27, 1889; xxiv, 321, Nov. 12, 1890.

A giant consolidation of steel interests occurred in Chicago in 1889, comparable with the concentration of the same industry in the hands of the Carnegie group at Pittsburgh. In this instance, as in the case of two other large consolidations to be mentioned later, the result was the formation of a vertical trust in which a single corporation controlled raw materials and all the essential agencies of production which it used in the manufacture of its final products. We have just noted that the North Chicago rolling mills represented a preliminary consolidation owning under two charters blast furnaces and an iron mill in Milwaukee and the new steel works in South Chicago with their appurtenant fuel and ore holdings, as well as the parent works in North Chicago. These last, however, were cramped by a narrow site and otherwise were not well placed to turn out steel and its manufactures economically under the new conditions of production. In 1889 this combination united with the Union Iron and Steel Company of Chicago and the Joilet Works which we have just described to form the Illinois Steel Company, with a capital of $25,000,000. The new corporation thus owned five plants, the North Chicago works, the South Chicago works, the Milwaukee works, the Joliet Steel Company's works and the Union Steel Company's works, embracing in the aggregate 14 blast furnaces in active operation producing nearly 650,000 tons of pig iron and spiegeleisen per annum; 4 Bessemer plants making more than 750,000 tons of ingots yearly, extensive coal lands, 1,150 coke ovens, several miles of railway with their rolling stock and mills for making rails, rods, plates and structural shapes. When extensions already under construction were completed open hearth-steel works and blast furnaces would be added to this equipment, increasing the annual capacity to 1,200,000 tons of pig and approximately the same quantity of steel per annum.

At this time the Illinois Steel Company was believed to have a larger output than any other steel company in the world, although it employed fewer men than the Krupp works at Essen. Its 10,000 employes turned out a larger product than the German establishment, partly because the latter was more largely engaged in making crucible steel and costly machinery. But the Carnegie Company was a close competitor, and when its projected plant enlargements were completed it was expected slightly to outdistance its western rival. The Illinois Company controlled outright or as a dominant stockholder some of the largest Bessemer ore mines of Minnesota, Wisconsin and Michigan. It owned directly a large tract of coking coal in the Connellsville district, ensuring it an ample supply of fuel for at least a quarter of a century. This consolidation was regarded when it was formed as "the most important event that had ever taken place in the history of the iron trade."[33]

In a statement issued at the time, the projectors of this consolidation declared that their moving purpose was economy. There would be a sav-

[33] American Iron and Steel Association, *Bulletin*, XXIII, 132, May 15, 1889.

ing in the cost of management, in the distribution and allotment of raw materials, and above all in diversifying and specializing the output of the new company's plants, thus avoiding in a degree the previous overstocking of the market with particular forms of steel and consequent periods of idleness. Among other suggestions was the confident one that tin plates would shortly be manufactured in Chicago.[34]

Almost immediately the new company took steps to provide for the future by purchasing large additions to its South Chicago site and abandoning its uneconomical rail mill in North Chicago.[35] Early in 1891, less than eighteen months after its organization, it increased its capital to $50,000,000, or double the original amount. The additional stock was issued in order to secure funds for necessary plant extensions. Among these projects was a large foundry to manufacture cast-iron pipe. The company made in 1892 nearly 785,000 tons of finished products or more than Sweden, Belgium or Russia.[36] Each annual report during these early years of its history mentions new plants or extensions of plants and new mechanical economies. An open-hearth furnace and a universal plate mill were built in order to supply materials for the growing shipbuilding industry on the Great Lakes. In 1893 the Company's holdings included several thousand acres of coal and coke lands in Pennsylvania and West Virginia, of iron lands in Wisconsin, and of timber lands in Michigan, besides stone quarries in Indiana.[37] It showed a deficit in the panic year of 1893, but this was due to writing-off vast sums, totaling nearly $1,500,000, to depreciation and shrinkage of values. During this disastrous year the works at South Chicago were operated less than nine months, the Union works were idle the whole season and the Joliet works were active only six weeks.[38] Consequently this period closes with a serious reaction for the Company, although as we shall see, the crisis was but temporary and preliminary to a period of quick recovery.

OTHER WESTERN WORKS

During the twenty years we are discussing, steel was substituted largely for iron in making nails, and partly as a consequence of this a number of smaller local works sprang up in the Upper Ohio Valley, financed in part by the nail makers of Wheeling.[39] The first Bessemer plant in the state of Indiana, which went into operation at Hammond in 1887, was also erected mainly to make soft steel suitable for nails.[40] Nor was all the steel made in

[34] American Iron and Steel Association, *Bulletin*, XXIII, 84, Mar. 27, 1889.

[35] American Iron and Steel Association, *Bulletin*, XXIII, 325, Nov. 27, 1889; XXIV, 253, Sept. 3, 1890.

[36] American Iron and Steel Association, *Bulletin*, XXV, 58, Mar. 4, 1891; XXVII, 66, Mar. 1, 1893.

[37] *Commercial and Financial Chronicle*, LVI, 419, Mar. 11, 1893.

[38] American Iron and Steel Association, *Bulletin*, XVIII, 43, Feb. 24, 1894.

[39] American Iron and Steel Association, *Bulletin*, XVIII, 107, Apr. 23 and 30, 1884; XX, 11, Jan. 13, 1886; XXVI, 5, Jan. 6, 1892.

[40] American Iron and Steel Association, *Bulletin*, XXI, 339, Dec. 7 and 14, 1887.

Illinois at this time produced in the vicinity of Chicago. A rolling mill of some importance, devoted chiefly to making iron rails, had been in operation at Springfield for many years. In 1878 it turned out some 26,000 tons of rails and fastenings. In 1880 this company introduced in the United States a new method of making steel, which had already been employed in Europe, and prepared to diversify its product by adding to its equipment facilities for rolling bars, merchant steel and plates. Some years later the Company put into operation two Bessemer converters in addition to its open-hearth plant, in order to produce steel for rails.[41]

Proposals for making iron and steel at the head of the Great Lakes, in the immediate vicinity of the ore, were discussed for many years before a Bessemer plant finally began operation at West Superior in 1892. These works used the product of the neighboring coke furnaces, which now went into blast. Their purpose was to manufacture ship plates and structural steel for the local shipyards and the growing cities of the West; and in fact the first steel made at this establishment was rolled into plates to be used for building whalebacks. In 1893 various interests in this region, including the steel plant in question, were consolidated and were rumored to have come under the control of the Rockefeller group. The new company, or community of interests, like its more powerful predecessors and rivals in Pittsburgh and Chicago, controlled its own ores, but it did not have an independent supply of coke.[42]

STEEL MAKING IN THE SOUTH

The South was slow to engage in making steel because its ores were more suitable for foundry irons, and furnaces found this branch of the industry so profitable that they had little inducement to enter a field where they were sure to meet Northern competition favored by every natural advantage. Most of the steel made in America for the first twenty years after the beginning of the Bessemer industry was produced by the acid process, which required ores with a minimum phosphorus content. These were abundant in the Lake Superior region and northern New York, but exceedingly rare in the South. Southern iron makers were slow to take up steel making, also because there was but a limited local market for this commodity. Their billets would have to be shipped, at least for a period, to the North for manufacture. It was doubtful whether after paying freight they could be laid down in the great consuming centers in competition with those made by Northern works. Furthermore, the period of vertical trust building had already begun, and our largest steel producers smelted their own pig iron from their own ore and fuel in their own establishments. To be sure, Bessemer pig was largely dealt with in the open market, and even

[41] American Iron and Steel Association, *Bulletin*, x, 301, Nov. 8 and 15, 1876; xii, 214, Sept. 11, 1878; xiv, 52, Mar. 3, 1880; xvii, 43, Feb. 14, 1883; xxi, 261, Sept. 21, 1887.

[42] American Iron and Steel Association, *Bulletin*, xxvi, 36, Feb. 10, 1892; xxvii, 35, Feb. 1, 1, 1893; xxvii, 45, Feb. 8, 1893.

the Carnegie and the Illinois companies went into this market for certain grades of iron, or for additional supplies in times of exceptional activity; but that market was most profitable, as a rule, precisely when foundry irons also were in keen demand.

Chattanooga, which preceded Birmingham as the leading iron-making center of the South, was the site of the first permanent steel works in that section. The earliest establishment of this kind was originally set up at Kingston, Tennessee, in 1876, but was removed to Chattanooga the following year. It was a little crucible plant embracing one puddling furnace, three 2-pot crucible furnaces, and a single hammer. This modest undertaking, originally known as the Providence Steel Works and later as the Southern Steel Works, continued to produce in a small way tool steel for drills and forgings during the remainder of the period we are now discussing.[43]

Next in point of time was an open-hearth plant erected at Chattanooga in 1878 by the Roane Iron Company for the purpose of making steel to be used for rails. Georgia ores were used. The original works consisted of two 8-ton open-hearth furnaces, and the first rails were rolled from steel produced in December 1878. They employed pig iron and crop ends imported from England. These furnaces continued to make steel rails until January 1883, when they were closed down during the depression of that year and never relighted.[44] By the time the steel industry had sufficiently revived to warrant resumption, the development of the Cranberry Mines of North Carolina gave these works a Bessemer ore of the highest grade and caused the Company to build a Bessemer plant in 1886, which went into operation the following spring.[45]

A year previous to this, however, in the spring of 1886, another company, the South Tredegar Works, made steel experimentally by the Bessemer process in Chattanooga. This steel, which was the first Bessemer metal produced in the South, likewise was made from Cranberry ore and was rolled into nail plates.[46] The Roane Company, in the spring of 1887, rolled the first steel rails ever made in the South outside of Wheeling. In October of the same year, the third Bessemer works in this section went into operation at the plant of the Old Dominion Iron and Nail Company, of Richmond, Virginia. That season, also, the first steel was made in Alabama by the open-hearth process.[47]

In 1889 the Southern Iron Company was organized and purchased a number of iron works, including the establishment of the Roane Iron Company. It at once erected a basic steel plant at Chattanooga, under the

[43] American Iron and Steel Association, *Bulletin*, XII, 44, Feb. 20 and 27, 1878.

[44] American Iron and Steel Association, *Bulletin*, XII, 125, May 22 and 29, 1878; XXI, 180, July 6, 1887.

[45] American Iron and Steel Association, *Bulletin*, XXI, 124, May 11, 1887.

[46] American Iron and Steel Association, *Bulletin*, XX, 245, Sept. 15, 1886; XXI, 317, Nov. 16, 1887; XXII, 77, Mar. 1, 1888; XXII, 332, Nov. 7 and 14, 1888.

[47] American Iron and Steel Association, *Bulletin*, XX, 109, Apr. 28, 1886.

direction of an English expert, Mr. B. Talbot, who invented a process of de-siliconizing iron which was later used commercially in that region. Late in August 1891 the first basic Bessemer steel ever produced in the South was made by the new owners in the old converter of the Roane Iron Company. The Southern Iron Company at this time owned 8 charcoal furnaces in Tennessee and Alabama, besides the Roane plant, but it proposed to use ordinary coke iron for steel making. The new process surmounted two difficulties which had hitherto prevented the production of open-hearth steel in this region and was therefore supposed to be certain of commercial success. It overcame the objection of silicon in the iron, and it obviated the necessity of using scrap which was hard to procure and costly in the South, where reproductive iron manufactures had not been established on a large scale. But after some 2,000 tons had been made at the new open-hearth furnaces of this Company, operations were discontinued. The steel was good, but economic conditions were unfavorable, and before the new enterprise got on its feet the depression of 1893 ensued. Meanwhile the basic open-hearth process had made great progress in the North, and Southern furnace owners found it more profitable for the time being to ship their pigs to this new market. Northern steel makers enjoyed the advantage of being able to mix this Southern pig with scrap and Bessemer pig from local sources, thus procuring a more varied and satisfactory mixture.[48]

Alabama furnace men were so busy producing foundry iron that they gave comparatively little attention to steel making until the early nineties, when the great increase of furnaces within the territory supplied by the new Pocahontas coke field increased competition from that quarter in the northern markets and set them to seeking new outlets for their pig iron nearer home. Several processes were developed and patented about this time for utilizing Southern ores for that purpose, but interest in steel making in the Alabama district did not crystallize immediately into practical progress. The most important enterprise of the pioneer period was the Henderson Steel Works, which started with a small experimental open-hearth plant erected in 1887, and made its first steel by a patented process in February of the following year. This plant used ordinary Birmingham pig—indeed, those of inferior quality for other purposes—and its product was a fair quality of tool steel. Within a year the Company increased its capital and erected a larger plant, producing 16 tons daily. It shipped steel, at least experimentally, to the Torrey Razor Company in Massachusetts and, after its new plant was in operation, contracted to supply a local rolling mill with steel for rails; but the venture did not prove permanently successful.[49]

[48] American Iron and Steel Association, *Bulletin*, xxiv, 85, Mar. 26, 1890; xxiv, 277, Sept. 24, 1890; xxiv, 301, Oct. 22, 1890; xxiv, 323, Nov. 12, 1890; xxv, 69, Mar. 11, 1891; xxv, 261, Sept. 2, 1891; xxvii, 2, Jan. 4, 1893; xxxi, 37, Feb. 10, 1887.

[49] American Iron and Steel Association, *Bulletin*, xxii, 77, Mar. 7, 1888; xxii, 90, Mar. 21, 1888; xxii, 181, June 6, 1888; xxii, 339, Nov. 21, 1888; xxii, 357, Dec. 5, 1888; xxiv, 139, May 21, 1890; xxvii, 37, Feb. 1, 1893.

THE TENNESSEE COAL, IRON, AND RAILROAD COMPANY

In the South, as in the Pittsburgh and the Chicago districts, a tendency to concentrate the iron and steel industry under the control of a single great corporation soon manifested itself. The Southern combination sprang from the Sewanee Mining Company, chartered in 1852, which five years later changed its name to the Tennessee Coal and Railroad Company. This company continued to operate under that name until 1881 without being distinguished in any way from neighboring concerns of a similar kind. The latter year it absorbed the Sewanee Furnace Company, and twelve months later the important Southern States Iron and Land Company, assuming on the latter occasion the corporate name, Tennessee Coal, Iron, and Railroad Company. These acquisitions made it one of the largest owners of mineral lands and furnaces in the South.[50] In 1886 it absorbed two other powerful rivals—the Pratt Coal and Iron Company and the Alice Furnace Company—and purchased the Linn Iron Works at Birmingham. Simultaneously with this consolidation, the enlarged corporation inaugurated a vigorous policy of plant expansion, contracting for five new furnaces with an aggregate daily capacity of 1,000 tons, and for 1,000 additional coke ovens.[51] In 1887, after the interests of the corporation had suffered from the attacks of Wall Street speculators, its principal stockholders formed a five-year voting trust.[52] At this time the corporation was said to be the largest single holder of ore lands and furnace plants in the United States. Two years later its monthly output of coal was 150,000 tons, and of iron 30,000 tons. As a result of a scientific study of furnace methods and raw materials, the product of its older furnaces was now about double their original capacity. This company was a large employer of convict labor.[53]

In 1892 Southern iron producers were startled by the rumor of a proposed consolidation of the Tennessee Coal, Iron, and Railroad Company and the De Bardeleben Coal and Iron Company. The De Bardeleben organization, which was capitalized for even more than the Tennessee Coal, Iron, and Railroad Company, had been incorporated in 1886 with a comparatively modest capital to build iron and steel works at Jonesboro, Alabama, but had subsequently multiplied its holdings by purchase and consolidation until it was one of the largest owners of ore lands in the South. These negotiations were mooted or under consideration for nearly two years, and the absorption of the De Bardeleben Company occurred in 1892. The new corporation, with unchanged name, had a share capital of $18,000,000, or $2,000,000 less than that of the amalgamating companies. The De

[50] *Commercial and Financial Chronicle*, XLIV, 245, Feb. 19, 1887; LIV, 486, Mar. 18, 1892.

[51] *Commercial and Financial Chronicle*, XLIII, 431–432, Oct. 9, 1886; American Iron and Steel Association, *Bulletin*, XX, 268, Oct. 6 and 13, 1886.

[52] *Commercial and Financial Chronicle*, XLV, 105, July 23, 1887.

[53] *Commercial and Financial Chronicle*, XLIV, 245, Feb. 19, 1887; XLIX, 690, Nov. 23, 1889; L, 628–630, May 3, 1890.

Bardeleben interests owned at the time 160,000 acres of coal and iron land, 7 blast furnaces and 1,040 coke ovens in Alabama. Its lands were so interlocked and interwoven with those of the rival company of which it now became a part, that their eventual control by a single management was demanded by the logic of geography. The same year the Tennessee Coal, Iron, and Railroad Company took over two other mining companies in Alabama, issuing $3,000,000 worth of additional stock for this purpose.[54]

In the Company's annual report for the year ending January 31, 1892, before the new properties were acquired, its management recommended "entering in the future into the production of steel." The Company had demonstrated its ability to deliver iron at a profit in every state of the Union, but the attention of the stockholders was called urgently to "the desirability of our undertaking such enterprises at home as may obviate the necessity of seeking our own markets over so wide an expanse of territory and losing the greater part of the benefits incident to the geographical position of our works and mines by the payment of freights to the markets in question."[55]

In the spring of 1893 a special committee, after an exhaustive investigation of the prospects for making steel in the South on the large scale suitable for the Company, reported to the stockholders that there was little hope of ever producing this metal profitably from Southern pig by the acid Bessemer or the acid open-hearth process. The basic Bessemer process permitted the utilization of a greater variety of Southern iron, but would necessitate the abandonment of some of the cheapest and best ores used in that region, and by limiting steel irons to those made from the brown ores of Georgia and Alabama would materially increase the cost of production. On the other hand, the basic open-hearth process could be used with pig smelted from almost any Southern ore, its only requirement being that the iron used should have a low content of sulphur, from which Southern ore and coke are reasonably free. In order to reduce the quantity of silicon, without employing scrap, which was scarce and expensive in that region, the management recommended that the rights to the Talbot process be purchased, and that a large plant be erected at once with a minimum capacity of 500 tons a day. This would afford a more flexible outlet than was then available for the Company's iron. The corporation's resources were almost imperial in extent. It owned 400,000 acres of coal and iron lands and 17 furnaces of large capacity. The steel works, which it was now proposed to erect, would constitute a fitting crown for this great enterprise.[56]

[54] *Commercial and Financial Chronicle*, LIV, 486, Mar. 19, 1892.
[55] *Commercial and Financial Chronicle*, LIV, 851, May 21, 1892.
[56] American Iron and Steel Association, *Bulletin*, XXVII, 99, Apr. 5, 1893.

THE COLORADO FUEL AND IRON COMPANY

Steel making west of the Mississippi before 1893 was practically confined to a single company, which began operations in the early eighties. Coal suitable for coking had been mined for several years in Colorado, where the smelters and railways afforded a ready market for it. In 1880 the Colorado Coal and Iron Company decided to build iron and steel works near Pueblo and additional coke ovens to supply them with fuel. At that time the Company owned nearly 1,000,000 acres of land, which it had purchased directly from the Government, near the line of the Denver and Rio Grande Railway, then under construction. It was primarily a land company, less than 15,000 acres of its holdings being known at that time to contain coal or iron ore.[57]

The erection of a blast furnace was begun immediately.[58] This was followed by a Bessemer plant which began operation early in 1882, by which time construction had already begun on a second and larger furnace. The new steel works, which included a rail mill and nail works, promised to be very profitable, both because they were built on the most modern plan and designed to economize costs of production to the utmost, and because the local market for their product was protected from Eastern competition by high railway freights.[59] In fact the subsequent vicissitudes of this corporation were due largely to the vagaries of competition induced by railway rate wars, as well as to the waxing and waning of its exclusively local market with the varying prosperity of the mining and smelting industries of the Rocky Mountain region. Its first contract for rails was with the Denver and Rio Grande Railway, and its subsequent fortunes were bound up for a time with those of the latter corporation. The first steel rail rolled west of the Missouri River was made at Pueblo in March 1882, and more than 1,600 tons were produced before the end of the year. The capacity of the nail works was 100,000 kegs per annum, which was "equal to the estimated demand of the Colorado market."

During the next few years the Company's profits were derived largely from its sales of coal and land, and the iron and steel works when in operation frequently showed a loss. In 1884 there were troubles in the management, and the steel works were shut down on account of "a conviction that the Company could not compete with Eastern manufacturers in making steel rails on account of the higher cost of fuel, labor, and refractories." This was a period of keen competition and railway rate cutting.[60] Never-

[57] *Commercial and Financial Chronicle*, XXXII, 366–367, Apr. 2, 1881.

[58] American Iron and Steel Association, *Bulletin*, XV, 122, May 18, 1881; XV, 242, Sept. 28, 1881.

[59] American Iron and Steel Association, *Bulletin*, XVI, 108, Apr. 12 and 19, 1882; XVI, 122, May 3, 1882; XVI, 233, Aug. 30, 1882; *Commercial and Financial Chronicle*, XXXVI, 650, June 9, 1883.

[60] American Iron and Steel Association, *Bulletin*, XVIII, 116, May 7, 1884; XIX, 85, Apr. 1, 1885; *Commercial and Financial Chronicle*, XL, 392–393, Mar. 28, 1885; XLII, 336–337, Mar. 3, 1886.

theless the corporation continued to add to its furnace capacity. In 1887 an increase of profits was "largely derived from the iron and steel department;" but the following year output was reduced and the Company's furnaces and converters were run at a small loss.[61] By 1890, again, the Company's furnace capacity had risen to 240 tons a day, and its steel works were running at full blast.[62]

About this time the steady fall in the price of silver and the growing opposition to bimetallism in the East paralyzed one of the principal mining industries of Colorado, and railway construction practically ceased. In 1892 the Company took advantage of the quiet period to make needed repairs and plant betterments. That year it united with the Colorado Fuel Company, changing its name from the Colorado Coal and Iron Company to the Colorado Fuel and Iron Company. The new capitalization was $13,000,000. After the consolidation the corporation owned 69,000 acres of proved coal lands, including 15 developed mines well situated for reaching different sections of the market, 800 coke ovens, 3 blast furnaces with an aggregate capacity of 300 tons of pig iron a day, steel works, rolling mills, iron mines and a foundry for making cast-iron pipe. By this time the Rockefeller interests had attained some prominence in its affairs.[63] In 1893, the directors felt "that it has been fully demonstrated that iron and steel can be produced at costs that will meet any competition and yield a fair margin of profit." Already, however, the stagnation of the silver mining and smelting industry, one of the largest consumers of coal and coke within its market area, was causing concern, and during the panic year the steel works were idle for some months.[64]

STATISTICS OF OUTPUT

In 1873, the seventh year since steel had been manufactured by the Bessemer process in the United States, the total output was 157,000 tons, of which 129,000 tons were represented by steel rails.[65] Although the iron industry as a whole was prostrated by the panic, the quantity of Bessemer steel made in the country steadily increased. It exceeded 500,000 tons in 1877, at which time American plants made more than double the amount produced in any other country except Great Britain.[66] During the first ten years of Bessemer production the proportion of "wrought iron and steel" made in the country which was produced by this process rose from 3 per cent to 38 per cent.[67] In 1880 the output of Bessemer steel ingots

[61] *Commercial and Financial Chronicle*, XLVI, 386, Mar. 24, 1888; XLVIII, 398, Mar. 23, 1889.
[62] American Iron and Steel Association, *Bulletin*, XXIV, 189, July 2, 1890; *Commercial and Financial Chronicle*, LII, 426, Mar. 14, 1891.
[63] *Commercial and Financial Chronicle*, LIV, 559, Apr. 2, 1892; LV, 373, Sept. 3, 1892; LV, 1040, Dec. 17, 1892.
[64] *Commercial and Financial Chronicle*, LVII, 373–374, Sept. 2, 1893; LVII, 1082–1083, Dec. 23, 1893.
[65] American Iron and Steel Association, *Bulletin*, IX, 268, Sept. 3, 1875.
[66] American Iron and Steel Association, *Bulletin*, XII, 60, Mar. 13, 1878.
[67] American Iron and Steel Association, *Bulletin*, XIII, 221, Sept. 3, 1879.

for the first time exceeded 1,000,000 tons and did so by the ample margin of 203,000 tons. American converters made more steel that year than they did during the entire first ten years of Bessemer production in this country, and more Bessemer steel, though not more steel including that made by other processes, than did Great Britain.[68]

Most of the Bessemer steel made in America up to this time had been used for rails. Consequently the prosperity of this industry depended upon that of the railways, and its growth was measured to some extent by the growth of railway mileage. To be sure iron rails were still rolled. In 1882, the last year when they made a considerable item in statistics of production, the output was 228,000 tons, compared with 1,438,000 tons of Bessemer rails. Growth of output in the industry as a whole slowed down in 1882, and during the following two years, as already mentioned, was replaced by a slight decrease, for the first time in its history. This was due entirely to a decline in the manufacture of steel rails, more ingots being used for miscellaneous products than any preceding season. From 1881 to 1883 inclusive, Great Britain again manufactured more Bessemer steel than did the United States, but rolled fewer Bessemer rails, our country leading the world in their production. In 1884, 5 of the 21 Bessemer plants in the country made no steel rails, their entire product being marketed in other forms, and the percentage of our total Bessemer output employed for rails had declined from 78 per cent to 72 per cent within a year.[69]

A new period of expansion began with 1885, notwithstanding a continued falling off in rail production, which was less than any other year since 1880; and again the proportion of the Bessemer steel produced in this country used for rails declined, this time to 63 per cent. This record steel production also occurred during a year when there was a considerable shrinkage in the quantity of pig iron made in the country.

Plant expansion continued apace, but several of the new works were comparatively small and were intended to make ingots for rolling into structural shapes, and into nail plates, wire rods, boiler plates and similar semi-manufactured forms. The Bessemer patents had expired and methods of manufacturing had been improved and cheapened, so as to create a market for steel in places where cheaper and less suitable metals had previously been used. In a general way larger steel plants had converted most of their product into rails, while smaller plants had produced for the miscellaneous market. But the period of rapid railway expansion in the middle eighties had eventually increased converter capacity far beyond the country's need for exclusively railway purposes and large steel makers thereupon took the initiative in finding other outlets for their products.[70]

Pennsylvania made about two-thirds of the steel produced in the United States and its output increased even in 1883 when the total product of the

[68] American Iron and Steel Association, *Bulletin*, xv, 36, Feb. 9, 1881; xv, 84, Apr. 6, 1881.
[69] American Iron and Steel Association, *Bulletin*, xix, 44, Feb. 18, 1885.
[70] American Iron and Steel Association, *Bulletin*, xx, 36, Feb. 10, 1886.

country declined. Open-hearth steel began to be used for rails about 1878, when nearly 10,000 tons were manufactured of this material. Its employment for this purpose increased until 1881, when more than 25,000 tons of open-hearth steel rails were made. Thereafter a decline occurred and the statistics showed only 1,400 tons in 1885. In 1875, 793,000 tons of rails were rolled in the United States, of which 291,000 tons were steel and 502,000 tons iron. Ten years later 1,091,000 tons of rails were manufactured, of which 1,076,000 tons were steel and only 15,000 tons were iron.[71]

In 1886, with a resumption of railway building, the proportion of all the steel made in the country converted into rails again increased, and the total product, in this twentieth year of the industry's introduction in America, suddenly rose to 2,541,000 tons. Of this amount 1,500,000 tons were made in Pennsylvania and over 500,000 tons in Illinois. The United States had now become the largest steel producer in the world, outstripping Great Britain in aggregate product on account of its excess of Bessemer, though the United Kingdom continued to make more open-hearth steel for several years thereafter.[72]

Up to this time no basic steel plant had ever been erected in America;[73] but the acid open-hearth process was gradually getting a foothold. Nearly 175,000 tons of steel were made by that method in 1887 and the output of open-hearth rails was again slowly mounting. These were years of marvelous growth in all departments of the industry. The production of Bessemer steel nearly doubled within two years, and that of open-hearth steel increased 47 per cent, from 245,000 to 361,000 tons, between 1886 and 1887.[74] The growth of open-hearth production was indicative of the notable increase in the use of steel for other purposes than rolling rails, a fact further testified to by the quantity of Bessemer steel manufactured into miscellaneous shapes, which rose from 231,000 tons in 1884 to 582,000 tons in 1887.

Steel production declined again in 1888, reached another new record the second year following, once more fell back in 1891, and attained the maximum for the period we are now considering in 1892, when the output of Bessemer ingots alone exceeded 4,660,000 tons. This was an increase of 1,000,000 tons over the previous year, although only 250,000 tons more Bessemer rails were made than the preceding season. In fact, continuing the tendency already noted, the production of steel had expanded in the face of an actual decline in the demand for rails. Between 1886 and 1891, moreover, the output of open-hearth steel rose from 245,000 to nearly 650,000 tons. The drop in rail production which came in 1888 with the shrinkage of new railway mileage had never been recovered.[75]

[71] *Commercial and Financial Chronicle*, XLII, 199–200, Feb. 13, 1886.

[72] American Iron and Steel Association, *Bulletin*, XXI, 28, Feb. 2, 1887; *Commercial and Financial Chronicle*, XLIV, 198–199, Feb. 12, 1887.

[73] American Iron and Steel Association, *Bulletin*, XX, 228, Sept. 1, 1886.

[74] American Iron and Steel Association, *Bulletin*, XXII, 68, Feb. 29, 1888; *Commercial and Financial Chronicle*, XLVI, 340, Mar. 17, 1888.

[75] American Iron and Steel Association, *Bulletin*, XXVII, 36, Feb. 1, 1893; *Commercial and Financial Chronicle*, LVI, 228, Feb. 11, 1893.

Several small works were erected in the United States in the eighties to make steel by various modifications of the Bessemer process. The so-called Clapp-Griffiths and Roberts-Bessemer processes were the most important of these. In 1892 there were five of the former and four of the latter plants in the United States. Their capacity was relatively small, the product never in the aggregate reaching 50,000 tons per annum.

OPEN-HEARTH STEEL

The history of the open-hearth process, though for many years hardly more promising than that of these minor rivals, is of more permanent interest because of its subsequent development. Its advantages, due to the greater variety of ores it could employ, were recognized several years before they made their influence felt in output statistics. During the rail-steel era that metal could be made more cheaply by the Bessemer process than by the open-hearth method; and the use of open-hearth steel was therefore limited largely to employments where very soft, very hard, or very pure products were required and cost was subordinate to quality. About 1879 several technical improvements, the most important of which were the Krupp process for washing ore and the Pernott revolving hearth, which nearly doubled the output of a regenerative furnace and facilitated repairs, were introduced, and the capacity of open-hearth plants was increased. Several large steel works, including the Cambria Company, the Pennsylvania Steel Company and the Springfield Iron Company, which were engaged in producing steel for general purposes, besides smaller companies that made a specialty of castings, springs and light miscellaneous shapes, erected improved furnaces of this type.[76] In 1884 there were 35 of these works in the United States. Two years later the number had risen to 42 plants embracing 91 furnaces with an aggregate capacity of 660,000 tons per annum, but actually making less than half of this amount. Thus it was nearly 18 years after the first open-hearth furnace was erected at Trenton, in 1868, before this branch of steel production received a decided impetus.[77] After 1890 its rate of progress was faster than that of the Bessemer industry and in spite of the dullness and reaction of 1890 and 1891, 17 new open-hearth plants began operation at that time.[78] The output of open-hearth ingots reached 670,000 tons in 1892, a modest quantity compared with the 4,168,000 tons of Bessemer steel produced in this country, or compared with the 1,500,000 tons of open-hearth steel made in Great Britain. But these figures foretold a development in the United States similar to that which had occurred abroad, where for some years this process had been steadily gaining upon the Bessemer method.

[76] A. L. Holly, Paper read before American Institute of Mining Engineers, *Transactions*, VII, 241–255, Feb. 1879; American Iron and Steel Association, *Bulletin*, XIV, 37, Feb. 11, 1880; XIV, 197, Aug. 11, 1880.

[77] American Iron and Steel Association, *Bulletin*, XX, 228, Sept. 1, 1886; XXI, 44, Feb. 16, 1887.

[78] American Iron and Steel Association, *Bulletin*, XXVI, 51, Feb. 24, 1892.

CRUCIBLE STEEL

In 1875, 44 establishments in the United States made cast, puddled, blister or open-hearth steel. Their total output was 61,000 tons, of which 40,000 tons were made by the crucible process and 9,000 tons by the open-hearth process.[79] While the demand for crucible steel was relatively limited compared with the remarkable increase in Bessemer consumption, production continued, upon the whole, to increase. In 1883 one of the finest plants in the country began operation at Chartiers, near Pittsburgh, with an annual capacity of 12,000 tons. Larger furnaces were coming into use, and ingots weighing more than six tons could be cast.

But America was still behind England and Europe in this branch of high-quality steel production, and her crucible steel makers were not uniformly prosperous. During the early eighties the Siemens-Anderson Company at Pittsburgh failed and the Adirondack Works at Jersey City, whose record of continuous operation since 1849 made them the oldest firm in the industry on this side of the Atlantic, were forced by dull business to shut down permanently.[80] Between 1884 and 1886 the annual capacity of American works actually declined from 115,000 to 110,000 tons, though the output increased because a smaller percentage of the existing plants were idle. This was due to the employment of open-hearth steel for purposes for which crucible steel had previously been used. Open-hearth steel was suitable for locomotive boilers and fire boxes, car springs and agricultural machinery, but it could not replace crucible steel for making fine springs, high-grade tools and cutlery. In 1892 the industry was reported to be making no progress, although it did not retrograde. At this time there were 45 plants in operation in the United States,[81] and during the decade between 1880 and 1890 the total output rose from 76,201 to 82,748 tons.[82]

[79] American Iron and Steel Association, *Bulletin*, x, 156, May 24 and 31, 1876.

[80] American Iron and Steel Association, *Bulletin*, xvii, 268, Sept. 26, 1883; xviii, 282, Nov. 5, 1884; xix, 195, July 22 and 29, 1885.

[81] American Iron and Steel Association, *Bulletin*, xx, 228, Sept. 1, 1886; xxvi, 51, Feb. 24, 1892.

[82] Eleventh Census, *Report on Manufactures, Selected Industries*, 422.

CHAPTER XXII

IRON PLANTS AND PROCESSES

SMELTING FUELS

While there was an increase in the quantity of pig iron smelted with anthracite coal and with charcoal during the twenty years we are describing, the expansion which had made the United States the largest producer of iron and steel in the world was due to the growing output of bituminous and coke furnaces, particularly the latter.

The survival of charcoal iron-making was due to the quality of the product. Furnace owners in this branch of the industry were organized as an independent association which held general meetings and actively promoted their common interests. To this fuel was due mainly the extension of iron making to certain states, notably Michigan. Another seat of the industry was the South, which made 31 per cent of the country's output of charcoal iron, though it made less than 19 per cent of all the iron produced in the United States.[1] In dull times foundry men substituted mixtures of coke iron and charcoal iron for purposes for which the latter was ordinarily used exclusively, but as soon as trade revived customers cheerfully paid the higher cost of charcoal iron in order to be sure of securing castings and forgings of a better quality. Its chief markets were foundries making car wheels and malleable castings.[2] During 1890 and 1891, sixteen new charcoal furnaces were erected in nine different states; three of these were in Texas and four in Michigan.[3]

In the anthracite furnace centers of eastern Pennsylvania, New Jersey and New York, the most significant development during this period was the substitution of mixtures of Connellsville coke with anthracite for anthracite alone. Experiments along this line appear to have been first suggested by the difficulty furnaces experienced in procuring hard coal during the great coal strikes of the middle seventies; but once introduced, the use of a coke mixture was discovered to be an advantage in itself. In 1875 when this practice first began to attract attention, eastern furnaces were reported to be "working better than they have ever done with an-

[1] Swank, *Iron in All Ages*, 352; Eleventh Census, *Report on Manufactures, Selected Industries*, 395, 406, 448, 452.
[2] American Iron and Steel Association, *Bulletin*, xxv, 41, Feb. 18, 1891.
[3] American Iron and Steel Association, *Bulletin*, xxvi, 50, Feb. 24, 1892.

thracite alone, carrying an increased burden and making iron of the best quality."[4] This year coke was transported 385 miles to New Jersey furnaces, where it was used with three times its weight of coal.[5] In the West the furnace at Milwaukee employed that year one-fourth Brier Hill coal and three-fourths Connellsville coke.[6] A few years later mixtures of coal and coke were employed in Ohio furnaces, where the experience of eastern Pennsylvania had been watched with interest, the accepted proportions being approximately equal parts of anthracite coal, native block coal and Connellsville coke.[7] We have already noted that the extension of the iron industry in the South was largely determined by the discovery and utilization of good coking coals in the Birmingham district and by the development of the Pocahontas field in the Virginias.[8] A great impetus was given to the use of coke by the growth of the Bessemer process, as uncoked coal oftentimes contained so much sulphur that it was available only for smelting foundry irons, a fault partly remedied by the coking process.

PETROLEUM AND GAS

Improvements in the art of handling fuel enabled iron makers to employ culm for steam production and for the manufacture of fuel gas, and the old slack heaps of the mining districts began to disappear.[9] In 1871 the Laclede Iron Works at St. Louis experimented with petroleum as a rolling-mill fuel with results which seemed to promise a great saving over coal. Six years later petroleum was used with reported success for making iron directly from the ore at Poughkeepsie, New York. In 1881 also, similar experiments were conducted by Dr. G. Duryee, of New York City, at Cleveland. The Norway Iron Works at Boston used vaporized petroleum in their heating furnaces in 1883, when the process seems to have passed the experimental stage; and in 1887 the Bethlehem Company, after successful experiments, adopted this fuel for reheating ingots. At this plant the petroleum was vaporized by the Archer gas-fuel process, which was adopted three years later by the Illinois Steel Company and the Pencoyd Iron Works.[10]

Several new systems of using producer gas in iron and steel making were also introduced with more or less success soon after 1880. An attempt to smelt ore with water gas was made at Norristown, Pennsylvania, in 1881. Six years later, Mr. Burdette Loomis, a Hartford inventor, installed a plant for generating fuel gas at the Disston Saw Works in Phila-

[4] American Iron and Steel Association, *Bulletin*, IX, 44, Feb. 18, 1875; IX, 61, Mar. 5, 1875; IX, 108, Apr. 16, 1875.

[5] American Iron and Steel Association, *Bulletin*, IX, 132, May 7, 1875.

[6] American Iron and Steel Association, *Bulletin*, IX, 204, July 9, 1875.

[7] American Iron and Steel Association, *Bulletin*, XIV, 61, Mar. 10, 1880.

[8] *Cf.* also American Iron and Steel Association, *Bulletin*, XXI, 332, Nov. 30, 1887.

[9] American Iron and Steel Association, *Bulletin*, XXIII, 218, Aug. 14, 1889; XXIV, 59, Mar. 5, 1890.

[10] American Iron and Steel Association, *Bulletin*, XV, 300, Nov. 23 and 30, 1881; XV, 317, Dec. 14, 1881; XVII, 69, Mar. 7, 1883; XXI, 341, Dec. 7 and 14, 1887; XXIV, 90, Apr. 2, 1890.

delphia. The Springfield Iron Company of Illinois, which pioneered several new inventions, experimented for two years or more with a process for making fuel gas invented by Dr. Alphonse Hennin, by which it was proposed to save the by-products, ammonia and tar, so as to make the latter pay for the cost of coal and of conversion. Some plants in the Pittsburgh district, loth to return to the use of coal when the declining supply and growing market so increased the cost of natural gas as to make its use unprofitable, experimented with producer gases in its stead. In 1891 fuel gas made by the Rose process was employed for puddling iron at Philadelphia, and the same year four companies in Pittsburgh were reported to be erecting generators for the same or similar purposes.[11]

But the great fuel episode of these twenty years was the employment of natural gas in rolling mills and steel works. As early as 1872 an effort was made to raise capital for erecting a blast furnace at Titusville to smelt Lake Superior ore with natural gas from a local well.[12] Two years later this fuel was successfully employed in puddling and heating furnaces connected with sheet iron works at Leechburg, Pennsylvania. Among other purposes for which it was used at this plant was heating annealling furnaces and the pots of tin into which sheets were dipped at this pioneer tin-plate establishment. Soon afterward the Etna Iron Works in Allegheny County employed the same fuel;[13] but it was ten years later before its use became general.[14]

Its introduction was retarded to some extent by the fact that prospective customers, with rare exceptions, did not own gas wells, and the companies which sold this fuel held it at prices approaching the cost of coal. None the less by the end of 1885 practically every iron and steel mill in Pittsburgh and vicinity was using natural gas. The following year it was introduced at the Cambria Iron Works at Johnstown. From the Pittsburgh district its use spread to Ohio and the vicinity of Wheeling, where it was employed successfully for melting pigs in cupola furnaces without the aid of coke or other fuel.[15]

The employment of natural gas in iron and steel works varied, of course, with the accessibility of the supply. It was the distance of the wells from existing works that retarded its general use during the decade following 1874; and in 1893 the discovery of important wells in Westmoreland County near Pittsburgh greatly enlarged the industrial consumption of this fuel. As late as 1884 only six rolling mills and steel works in the United States

[11] American Iron and Steel Association, *Bulletin*, xv, 235, Sept. 21, 1881; xxi, 75, Mar. 23, 1887; xxv, 181, June 17, 1891; xxv, 229, Aug. 5, 1891; xxv, 269, Sept. 9, 1891; xxv, 299, Oct. 14, 1891.

[12] American Iron and Steel Association, *Bulletin*, vi, 379, July 31, 1872.

[13] American Iron and Steel Association, *Bulletin*, viii, 284, Sept. 24, 1874; xxviii, 133, Sept. 10, 1904; *cf.* also *id.*, ix, 252, Aug. 20, 1875; ix, 348, Nov. 9, 1875; xi, 97, Apr. 11, 1877.

[14] Hall, *America's Industrial Center* (Pittsburgh Chamber of Commerce Publication, 1891), pp. 37–38, 40, 47.

[15] American Iron and Steel Association, *Bulletin*, xix, 173, July 1, 1885; xx, 229, Sept. 1, 1886; xx, 293, Nov. 3 and 10, 1886; xxi, 181, July 6, 1887.

used natural gas; two years later this number had risen to 68, and by November 1887 it was 96 or nearly one-fourth of the establishments in the country. Of these, 57 were in Allegheny County, 15 in other parts of western Pennsylvania, 7 in Wheeling and vicinity, and 17 in Ohio, principally at Youngstown, to which city gas was piped from Pennsylvania. The Indiana discoveries did not become important until later.[16]

By 1889, however, the change from coal to gas already showed signs of slackening, on account of a diminished supply and the diversion of this fuel from manufacturing to domestic uses. This year 21 rolling mills and steel works were using petroleum, either wholly or in part. About the same time certain large concerns, such as Jones and Laughlin, were reaching out for independent supplies of natural gas. The following year the Carnegies extended their own pipe line from Homestead and Braddock to the new fields in Washington County. By this time, however, some large works began to resume the use of coal, partly on account of the diversion of gas to other uses where it commanded a higher price. The supplying companies had been selling their product under contract to steel makers for ten cents or less a thousand feet. When the demand increased they could dispose of all the gas available to householders for double that rate.[17]

As previously mentioned, not all the works which abandoned natural gas went back to coal. In 1890 the Smythe and Laughlin Company of Pittsburgh changed from natural gas to producer gas made from slack coal, and several other firms were reported to be considering the same measure.[18] So speedy was the transition that it was announced in 1891 that an advance of five cents per thousand cubic feet in price made by the natural gas companies the first of October 1891 would "practically be the end of natural gas in the mills and manufacturies of Pittsburgh."[19] This prediction did not prove true, for when some establishments withdrew their custom the others found their supply larger and more regular than formerly. New wells were being opened, though not in sufficient numbers to compensate for those which ceased production.[20] The secretary of the Iron and Steel Association, in reviewing the history of this fuel in that industry, recapitulated the number of iron and steel works where it was employed, as follows: September 1884, 6; August 1886, 68; November 1887, 96; December 1889, 104; December 1892, 74. There had been an increase in Indiana but a decrease everywhere else. In fact the opening of the Indiana field had resulted in the establishment of several new iron and steel enter-

[16] American Iron and Steel Association, *Bulletin*, XXI, 354, Dec. 28, 1887; XXII, 348, Nov. 28, 1888.
[17] American Iron and Steel Association, *Bulletin*, XXIII, 53, Feb. 20, 1889; XXIV, 20, Jan. 22, 1890; XXIV, 141, May 21, 1890; XXIV, 325, Nov. 12, 1890; XXIV, 365, Dec. 24, 1890.
[18] American Iron and Steel Association, *Bulletin*, XXIV, 229, Aug. 6 and 13, 1890.
[19] American Iron and Steel Association, *Bulletin*, XXV, 277, Sept. 16 and 23, 1891.
[20] American Iron and Steel Association, *Bulletin*, XXV, 357, Dec. 2, 1891.

prises in that state. Commenting on this change, the secretary of the Association said:

"In most of the works which have been compelled to abandon or partly abandon the use of natural gas, a return has been made to the use of bituminous coal, but some of these works have also introduced the use of producer gas made from coal or petroleum and in a few works petroleum or gas made from coal is now principally used."[21]

BLAST-FURNACE CONSTRUCTION AND PRACTICE

Blast-furnace construction and practice, which were already shifting from an empirical to a scientific basis during the ten or twenty years preceding 1873, were almost revolutionized during the two decades that followed. In 1892 the British Iron Trade Commission reported:

"Modern iron making in America began when, in 1881, the long-doubted rumor became a certainty, that Captain William R. Jones and Julian Kennedy had by means of high heats and large volume of blast, succeeded in more than doubling the output of the Edgar Thomson furnace without altering the plant. It became firmly established when Andrew Carnegie was the first to recognize and act on the necessity for the successful iron producer to control his own material, and it gained international importance when this wonderful man joined to plants and mines the possession of railroads and ships."[22]

This opinion apparently balances credit for the progress of the industry in America between improved technique and perfected organization. How ever this may be, the introduction of the Whitwell hot-blast stove in the United States, which occurred in 1874 and 1875, immediately reduced the fuel consumption of the furnaces where it was employed and enabled a higher temperature to be attained.[23] The maximum furnace output in America at this time was about 600 tons a week. Certain changes were made in interior construction. The old straight boshes were discarded. Temperatures were raised several hundred degrees. The number of tons of iron made per day relatively to the cubic capacity of the furnace rapidly rose.[24] In 1877 Great Britain's record furnace made 804 tons in a week. Three years later Pittsburgh furnaces were producing above 200 tons a day and in 1882 they ran as high as 1,800 tons a week. After this the ratio of increase was not so rapid. At the opening of this period England used higher blast pressure and higher temperatures than the United States, whereas at the close of the period Americans were said to use double the pressure used by British furnace men, or 10 pounds per square inch, and fully as high-blast temperatures as Great Britain, and single furnaces were making from 2,500 to 3,000 tons a week.[25]

[21] American Iron and Steel Association, *Bulletin*, XXVI, 51, Feb. 24, 1892.

[22] British Iron Trade Commission, *Report*, 400.

[23] American Iron and Steel Association, *Bulletin*, VIII, 5, Jan. 1, 1874; IX, 235, Aug. 6, 1875.

[24] American Iron and Steel Association, *Bulletin*, VIII, 284, Sept. 24, 1874; VIII, 341, Nov. 12, 1874.

[25] American Iron and Steel Association, *Bulletin*, XI, 161, June 13 and 20, 1877; XIV, 292, Dec. 1, 1880; XXV, 89, Apr. 1, 1891; XXVI, 33, Feb. 10, 1892; *cf.* Bridge, *Inside History of the Carnegie Steel Company*, 57, 58, 70, 166.

Naturally many old-fashioned plants survived. Furnace construction and furnace practice probably varied more widely in different sections of the United States than in any country of Europe, and possibly than in the continent of Europe as a whole. In 1874 every furnace with a single exception in the famous Hanging Rock district of Kentucky was built after the old model, with a massive stone stack in the form of a truncated pyramid erected against a hillside at the base of which the rock was excavated to make room for its foundations. Ore and charcoal were hauled in wagons to a stock bank on the hill at a level with the furnace throat. Boilers were placed over the furnace throat and the hot-blast ovens were at the end of the boilers. A single cylinder engine drove a double blast. Sandstone was still used for the hearth and had given way to fire brick for furnace linings only within the last few years.[26] At the same time a day's journey further up the Ohio River, in the Pittsburgh district, all the furnaces consisted of a fire brick shell with a boiler-plate casing. The throats were closed by a bell and hopper charger; the gases were taken off at the side and led down through flues to the hot-blast stoves and boilers. As yet regenerative heating had not been applied, the hot-blast apparatus consisting of vertical cast-iron pipes, heated by burning around them gases from the furnace, through which the blast was forced. The largest furnaces of this period were 75 feet high and 20 feet in diameter at the boshes. About 20 years later, toward the close of this period, the largest furnace in the United States, at Braddock, was 90 feet in height and 22 feet in diameter at the bosh. The growth in capacity, therefore, was largely due to improvements in furnace practice rather than to increased size.[27]

In 1875, after a long struggle with financial obstacles due to the panic and to the technical difficulties which usually attend new ventures, the Etna Furnace went into blast at Ironton, Ohio. It possessed two features, borrowed from Great Britain, which were then unique in this country—the Ferrie self-coking system of Scotland and the Whitwell firebrick hot-blast stove, which was already extensively used in the Cleveland district of England. Ohio and Mississippi coals are not strong enough to carry a heavy furnace burden. Coke made from them is poor and soft; and this coal loses fully a third of its carbon in the coking process. The Ferrie device was adopted with a view to accomodating furnaces to this fuel. The stack was 87 feet 6 inches tall, an unusual height at that day, and the throat above 50 feet was divided into four quadrants by brick partition walls, supported by two arches sprung across its center at right angles to each other. This furnace after working somewhat unevenly at first, averaged about 70 tons a day when using coal and ore much inferior to

[26] Kentucky Geological Survey, *Report of Progress*, I, 322.

[27] American Iron and Steel Association, *Bulletin*, VIII, 155, May 14, 1874; XXIV, 69, Mar. 12, 1890; *cf.*, however, E. N. H. Talcott, "The Manufacture of Pig Iron," in American Society of Civil Engineers, *Transactions*, I, 196, for accounts of Lehigh Valley and New Jersey furnaces of equal or larger dimensions in 1869.

those employed at Pittsburgh.[28] Nevertheless this type of construction was not widely imitated.

AVERAGE FURNACE OUTPUTS

Average furnace output naturally varied from year to year with the fluctuating activity of the industry. In periods of depression fewer furnaces were working, but these were as a rule the larger and more efficient stacks. Their greater capacity tended to raise average output; but this was counterbalanced to some extent by the fact that many plants were not so continuously in blast as during seasons of prosperity. Charcoal furnaces had a smaller average capacity than anthracite furnaces, and anthracite furnaces were smaller as a rule than those using coke. No very reliable statistics of average capacity exist for the earlier period. Between 1887 and 1892 average output rose from 18,885 tons to 26,641 tons per annum;[29] and between 1874 and 1892 it apparently increased from about 6,500 tons to 38,600 tons.[30] During 1877, the 270 furnaces in blast made 2,066,594 tons of iron; during 1901, 266 furnaces produced nearly 16,000,000 tons.[31]

BLOOMERIES

Some iron continued to be made directly from the ore in bloomeries. The quantity so produced in 1873 was in round numbers 33,000 tons, made mostly in New York, North Carolina and Tennessee. In 1874 when the product of these forges increased to 36,000 tons, there were three such establishments in operation in Vermont. The largest works of this kind, at Chateaugay Lake, in Franklin County, New York, contained two forges with 10 fires and had a capacity of 4,000 tons per annum. Their product was used largely for manufacturing crucible steel and wire.[32] In 1875 the quantity of blooms made directly from the ore declined one-third. The following year a device for roasting ores in retorts attached directly to Catalan forges was invented and put into operation in northern New York. It was designed to make iron of a very high quality and in this respect seemed to have succeeded. At that time America was still dependent on Sweden for its best steel irons.[33]

During the next decade the production of bloomery iron continued to decline rapidly. Many of the old forges in New York, North Carolina and Tennessee were abandoned and their ore lands, if valuable, were sold to furnace men. In 1887 the Martic Forge in Lancaster County, Pennsylvania, which was built in 1755 and remained in operation until 1886, was

[28] American Iron and Steel Association, *Bulletin*, x, 33–34, Feb. 2, 1876; x, 41, Feb. 9, 1876.

[29] American Iron and Steel Association, *Bulletin*, xxvi, 50, Feb. 24, 1892.

[30] *Mineral Industry*, ii, p. 350.

[31] American Iron and Steel Association, *Bulletin*, xxxvi, 44, Mar. 25, 1902.

[32] American Iron and Steel Association, *Bulletin*, viii, 193, June 25, 1874; ix, 268, Sept. 3, 1875; x, 10, Jan. 12, 1876.

[33] American Iron and Steel Association, *Bulletin*, x, 156, May 24 and 31, 1876; x, 322, Dec. 13, 1876.

finally dismantled. Between 1884 and 1886 the number of bloomeries which made wrought iron directly from the ore decreased from 70 to 50. This was due mainly to the abandonment of plants in the Southern states, where cheap rolled bars and steel were rapidly displacing in local trade the hammered bar iron of the forges. Nevertheless, some of these forges survived up to the end of the period we are now describing. They disappeared entirely from the South soon after 1890. By 1892 only 10 were reported in the country, 9 of which were in New York and 1 in New Jersey. The Chateaugay Forge was still in operation, though only 9 of its 16 fires were going. In fact with the growing value of timber Catalan process iron had become too costly; for it took the charcoal from more than 8 cords of wood to produce one ton of blooms.[34]

FOUNDRY IRON

While the outstanding feature of pig-iron production during these twenty years was the manufacture of Bessemer pigs, important progress was also made in the production of superior foundry iron. In the seventies a strong prejudice existed in many parts of the United States in favor of Scotch pig iron for finer castings. The latter was highly esteemed for its great fluidity, slight shrinkage in the mold, and ability to take up scrap. Furnace men in the Mahoning Valley developed an "American Scotch pig iron" having qualities practically identical with the best imported, by using local black-band ores with a mixture of one-fourth Lake Superior ore; and by the end of the eighties America was making practically all its high-grade foundry irons at home.[35] The greater tensile strength of American castings, which had been recognized as far back as the eighteenth century, was never disputed. That quality explained in part why American carwheels and even locomotive driving wheels were made of cast iron, although English engineers with better road-beds and smoother track found it necessary to use wrought iron for this purpose.[36]

SPIEGELEISEN

With the introduction of the Bessemer process in America a growing market was created for spiegeleisen. It was early discovered that in making Bessemer steel the molten iron in the converters began to take up oxygen before all the carbon was removed. This excess oxygen rendered the product useless for most purposes. Consequently it was necessary to add to the iron in the converter a material with greater affinity for oxygen than iron itself possessed. Either silicon or manganese had this quality, but silicon deteriorated the iron even more than the oxygen which it was de-

[34] Swank, *Iron in All Ages*, 142, 297–300; American Iron and Steel Association, *Bulletin*, xx, 228, Sept. 1, 1886; xxi, 60, Mar. 2 and 9, 1887; xxi, 77, Mar. 23, 1877; xxiii, 12, Jan. 16, 1889; xxiv, 293, Oct. 15, 1890; xxvi, 51, Feb. 24, 1892.

[35] American Iron and Steel Association, *Bulletin*, viii, 355, Nov. 26, 1874; xvii, 292, Oct. 17, 1883.

[36] American Iron and Steel Association, *Bulletin*, xv, 243, Sept. 28, 1881.

sired to remove. Hence manganese, usually in an alloy with iron known in Germany as spiegeleisen, was the corrective material universally employed.

Almost as soon as Americans began to make Bessemer steel, therefore, they began to make spiegeleisen, though not in sufficient quantities to supply their needs. The first regular manufacturers of this product were the New Jersey Zinc Company, at Newark; but late in 1875 the Bethlehem Iron Company and the Cambria Iron Company began to make spiegeleisen from Spanish ores, and the Woodstock Company from Alabama ores. In 1887 nearly a fourth of the spiegeleisen consumed in America was produced in this country, the remainder coming mainly from Prussia and partly from England and France. Other companies entered this field. It was made in Georgia. The old Oxford Iron Company in New Jersey employed one of its furnaces intermittently in the manufacture of this product. Between 1885 and 1891 the output rose from less than 8,000 tons to over 21,000 tons. In 1883 spiegeleisen was produced in Colorado from local ores and was tested practically in the Bessemer works of the Colorado Coal and Iron Company. Most of the domestic ore came from Virginia, Georgia and Arkansas, however, although manganese is widely distributed in the United States.[37]

CONTEMPORARY REVIEWS OF PROGRESS

In 1881 the President of the American Institute of Mining Engineers, in reviewing the progress of the mining and metallurgical industries of the country during the preceding decade, cited, among the great improvements invented or adopted in America during this period, the use of regenerative stoves with blast furnaces of large hearth area, resulting in a great increase of output in a plant of given size and a reduction of more than half in the amount of fuel required to puddle a ton of iron.[38] In 1887 the editors of the *Directory of the American Iron and Steel Association*, in a survey of the progress of the industry since the first edition of that volume was published in 1873, noted as the most important changes that had occurred during that period, the development of the Bessemer steel industry, the substitution of steel rails for iron rails, the promising growth of the open-hearth process, the general adoption of coke as a smelting fuel, the introduction of natural gas in rolling mills and steel works, and the advent of the steel cut nail and the wire nail. During this period a noticeable decline occurred in the manufacture of rolled iron in New England, accompanied by a tendency in the same section to engage in the production of steel. These years also witnessed the great expansion of the iron industry in Alabama and Tennessee.[39] Fourteen years later John Birkenbine, a veteran metal-

[37] American Iron and Steel Association, *Bulletin*, IX, 268–269, Sept. 3, 1875; X, 12, Jan. 12, 1876; XI, 185, July 11, 1877; XI, 196, July 18 and 25, 1877; XII, 193, Aug. 21 and 28, 1878; XIII, 60, Mar. 12, 1879; XIV, 84, Apr. 7, 1880; XVI, 84, Mar. 22, 1882; XVII, 298, Oct. 24 and 31, 1883; XXIV, 157, June 4, 1890; XXV, 161, June 3, 1891.

[38] American Iron and Steel Association, *Bulletin*, XV, 66, Mar. 16, 1881.

[39] American Iron and Steel Association, *Bulletin*, XXI, 354, Dec. 28, 1887.

lurgical engineer, reviewed in a paper read before the fortieth anniversary meeting of the American Institute of Mining Engineers, the history of pig-iron production during the forty years beginning with 1871. He mentioned as notable steps in the progress of that period, the introduction of natural gas as a fuel, the predominant employment of coke in blast furnaces, the production of basic steel, the general replacement of iron by steel, the use of mixtures of molten metal, the manufacture of American tin plate, and the construction of iron and steel ships, armor plate, steel cars and structural steel buildings. In iron smelting particularly he spoke of regenerative hot-blast stoves, by-product coke and by-product charcoal ovens, skip-hoists, liberal water cooling, and dry-air blasts, which combined to increase product, lower fuel consumption, reduce labor costs and control the quality of the metal made.[40]

PUDDLING FURNACES

We have already traced the change in the processes of refining iron from the colonial period, when the forge fire and the trip hammer were exclusively employed, through the mid-century era of the Republic when the puddling furnace and the rolling mill displaced to a large extent these more primitive devices and made it possible to increase the quantity of wrought iron produced to the point where railways became possible, and into the age of steel, when a radically different and much more efficient process promised to supply metal in abundance for every conceivable use which man's ingenuity could devise. But these three periods are not divided from each other by hard and fast boundaries. We have just seen that the bloomery forge survived until the closing years of the century. Similarly puddling furnaces not only survived, but they continued to increase in number and capacity until well down into the age of steel.

During the depression following the panic of 1873, several puddlers' strikes occurred in different parts of the country, especially the Pittsburgh district. The men were paid on a piece-work scale, which ranged from less than $4 a ton for puddled iron at some Eastern works to $6 a ton in the West. There are two kinds of puddling, but this term was usually applied to both processes in America. In the first the purification of the iron is carried to a point where it becomes granular and is then softened by the continuous application of heat until it can be formed into a ball. In the second process, commonly called boiling in Great Britain, the iron is kept fluid throughout the operation. Puddling produced a somewhat harder iron than boiling and was used for making rail iron before steel was employed for that purpose.[41] The puddlers, who included "boilers," were well organized. Those of the Pittsburgh district were assisted by their fellow puddlers elsewhere during a protracted strike in the winter of 1874–75.

[40] American Iron and Steel Association, *Bulletin*, XLV, 69, July 15, 1911.
[41] American Iron and Steel Association, *Bulletin*, VIII, 365, Dec. 3, 1874.

Their society extended from Milwaukee to Troy, but does not seem to have included the little puddling mills in the South. In any case negro strike breakers from that section were employed to some extent at Pittsburgh as early as 1875.[42]

While the labor unrest of this period may not have directly suggested the efforts to perfect mechanical puddling that then occurred, it is probable that this series of strikes and lock-outs encouraged the adoption of such improvements as soon as they appeared in the market. The most successful of these was the Danks revolving puddling furnace, which was invented by an iron manufacturer and engineer in Cincinnati and was employed with partial success at several works in the West.[43] It was introduced in Great Britain in 1873, where it was received with favor and enlarged and strengthened structurally to increase its output. It was also used in a modified form in France and probably elsewhere on the Continent.[44] Although this device was reported to save labor, economize fuel and increase the yield of refined iron from a given quantity of pig, it was by no means universally employed even in America. In the early eighties it had gained a foothold in the Pittsburgh district after having been discarded by some of the plants where it had first been used. One obstacle to its introduction seems to have been its high initial cost at a time when the Bessemer process was encroaching upon the market for rolled iron.

The substitution of steel for iron in rails naturally checked the multiplication of puddling furnaces; but they did not immediately decline in number. New uses and expanding markets were discovered for wrought iron in spite of the supremacy of the rival method. Ordinary puddling furnaces were comparatively cheap affairs, and were not fastidious as to the quality of iron they received for refining. They were used to make most of the blooms converted into crucible steel; and since they could employ natural gas as well as a steel furnace, they continued to thrive, partly for that reason, during the years when the latter fuel was abundant. In 1888 a new economy—though not so absolutely novel as its promoter thought—was inaugurated at the Milwaukee works of the North Chicago Rolling Mills, where the molten iron was transferred directly from the blast furnace to the puddling furnace, thus saving time and fuel.[45]

Although the decline and eventual disappearance of puddling was freely predicted as soon as Bessemer steel was produced extensively in this country, new furnaces were constantly being erected. In fact it was not Bessemer steel, but open-hearth steel that was to prove the more aggressive rival of

[42] American Iron and Steel Association, *Bulletin*, VIII, 124, Apr. 16, 1874; VIII, 372, Dec. 10, 1874; IX, 90, 93, Apr. 2, 1875; IX, 99, Apr. 9, 1875; IX, 117, Apr. 23, 1875; IX, 139, May 14, 1875; IX, 157, May 28, 1875; IX, 316, Oct. 22, 1875; IX, 363, Dec. 3 and 10, 1875.

[43] American Iron and Steel Association, *Bulletin*, VII, 371, July 23, 1873; VII, 393, Aug. 13, 1873; XVI, 266, Oct. 4, 1882; XIX, 314, Nov. 25, 1885.

[44] American Iron and Steel Association, *Bulletin*, VII, 437, Sept. 17, 1873; VII, 473, Oct. 29, 1873; IX, 362, Dec. 3 and 10, 1875; XIV, 274, Nov. 10, 1880.

[45] American Iron and Steel Association, *Bulletin*, XV, 197, Aug. 3, 1881; XX, 269, Oct. 6 and 13, 1886; XXII, 36, Feb. 1, 1888; XXIII, 37, Feb. 6, 1889.

wrought iron in the latter's remaining field of consumption. The statistician of the American Iron and Steel Association reported in 1892 that the production of puddled iron in the United States was "not by any means a decaying industry." American works rolled more iron in 1890 than ever before in their history. Between the close of 1887 and January 1892, the number of puddling furnaces in the country increased from 4,882 to 5,120, the maximum number before their permanent decline began.[46]

IRON ROLLING

Iron rolling was closely associated with puddling, which stood to the former in the same relation that the Bessemer converter then stood to the rail mill. Notwithstanding the growing employment of steel in place of wrought iron, the latter was still preferred for many purposes, especially where resistance to rust and to deterioration under strain were required. During the seventies no steel vessels were built in America, but the shipyards of Wilmington afforded a sufficient market for iron ship plates, beams and boiler iron, to encourage the establishment of rolling mills in that city.[47] Bridges were still built of iron and this alone afforded a large and rapidly growing market for rolling mill products. Many small establishments were scattered through the South, each consisting of a little mill and one or two puddling furnaces, which were engaged chiefly in making iron for nails and for blacksmith use. Larger establishments with 15 to 20 puddling furnaces or more clustered around Wheeling, the great nail-making center of the United States.[48]

Not all the rolling mills of the seventies, however, had puddling furnaces or any device for refining iron; for many limited their operations to rolling rails. Mills of this kind were erected at Topeka, Laramie and several other points in the West. The market for structural iron was growing rapidly. In 1878 the Union Iron Company of Buffalo rolled beams which finished 50 feet in length and 15 inches deep with heavy flanges, weighing altogether 3,333 pounds. Of all the iron and steel rolled in the United States in 1874, or well toward 2,000,000 tons, more than half was employed for other purposes than making rails.[49]

In 1875 an improved roll-train was perfected at Cumberland, which would roll tapered iron such as was required for railway frog points, switch tongues, ship knees and other articles, down to harrow teeth. In 1878 a reversing two-high rolling mill, built in Leeds, England, was installed by the Cambria Iron Company, where three-high mills had been invented and first used. The following year other reversing two-high mills, of American design, were set up in the Pittsburgh district. Mills of this type accomplished what

[46] American Iron and Steel Association, *Bulletin*, xxiii, 5, Jan. 2 and 9, 1889; xxvi, 51, Feb. 24, 1892.

[47] American Iron and Steel Association, *Bulletin*, ix, 3, Jan. 8 and 15, 1875.

[48] American Iron and Steel Association, *Bulletin*, viii, 185–187, June 18, 1874.

[49] American Iron and Steel Association, *Bulletin*, viii, 221, July 16, 1874; ix, 267, Sept. 3, 1875.

the three-high mill, which never was generally used abroad, had been designed to accomplish—that is, the passage of the iron between the rollers in both directions. At this time or soon afterward the development of trains and of universal mills which evened the edges of plates while they were being rolled, rendered both the three-high mill and the reversible two-high mill out of date for many purposes. Within a decade devices had been perfected which rolled numerous metal shapes previously made under the forge hammer.[50]

Meanwhile, however, the rapid growth of the steel industry and its encroachment upon markets hitherto supplied by local iron mills, drove many of the latter out of business. In 1877 the sale of several plants in Ohio and Michigan for a fraction of their cost was noted. The old rail mills of the Baltimore and Ohio Railroad were shut down.[51] But simultaneously with the passing of these establishments, new works were erected and old ones extended at points accessible to markets which still demanded iron in preference to steel. Some of the decadent mills owed their depreciation to a long period of idleness, dating back in some instances to the panic of 1873, nearly seven years before. In 1879 a rolling mill at Spuyten Duyvil resumed operations after having been inactive almost eight years. The same season the rolling mills at Palo Alto, Pennsylvania, were started after an equally protracted period of idleness.[52]

With the general revival of business during the next few years, and the resumption of building operations and railway construction, iron workers as well as steel men were flooded with orders. In 1880 the Phoenix Iron Company of Pennsylvania was simultaneously building an iron bridge 1,000 feet long across the Harlem, 2,000 feet of railway bridge between Hull and Ottawa, several other bridges in Canada, where it had underbid English competitors, and a number of railroad bridges in Mexico, in addition to which it was rolling structural iron for Government buildings in the United States.[53]

In 1874, after long experiment and many discouraging results, Russian sheet iron was successfully made at McKeesport, Pennsylvania. This planished iron was regarded as superior to that imported, and was largely used for jacketing locomotives, for which employment it almost entirely displaced foreign iron. In fact, American locomotives thus covered were shipped in considerable numbers to Russia itself.

Between 1884 and 1886 the number of iron-rolling mills began to decline and some old firms went out of business. Notable among these was the Abbott Iron Company of Baltimore, which had rolled the heaviest plates in this country at the time the *Monitor* was built and had

[50] American Iron and Steel Association, *Bulletin*, x, 44, Feb. 9, 1876; xv, 3, Jan. 5, 1881; xxii, 197, June 20, 1888; xxvi, 108, Apr. 20, 1892; xxvi, 114, Apr. 27, 1892.

[51] American Iron and Steel Association, *Bulletin*, xi, 269, Oct. 10, 1877.

[52] American Iron and Steel Association, *Bulletin*, xiii, 213, Aug. 20 and 27, 1879; xiii, 221, Sept. 3, 1879.

[53] American Iron and Steel Association, *Bulletin*, xiv, 185, Aug. 4, 1880.

grown up around forges started by Peter Cooper in 1828. Similar establishments in New England closed down permanently, being unable to compete with mills at points where fuel was cheaper.[54]

Partly encouraged by the heavy duties imposed by the McKinley tariff, several rolling mills began soon after 1890 to make cotton ties. Another effect of that legislation was to build up behind a high-tariff barrier the domestic manufacture of tin plates. This resulted in the conversion of some rolling mills into plants especially designed to supply black sheets for the new industry. Even as recently as the early nineties charcoal iron was considered by many the only suitable material for tinning.[55]

[54] American Iron and Steel Association, *Bulletin*, xx, 211, Aug. 11, 1886; xx, 228, Sept. 1. 1886; xx, 293, Nov. 3 and 10, 1886; xxi, 61, Mar. 2 and 9, 1887.

[55] American Iron and Steel Association, *Bulletin*, xix, 115, May 6, 1885; xxvi, 149, May 25, 1892; *Manufacturers' Record*, xx, 6, Nov. 28, 1891.

CHAPTER XXIII

STEEL PLANTS AND PROCESSES

EARLY CONVERTER RECORDS

During the early years of Bessemer production in America much rivalry existed among the comparatively small number of independent plants, each of which strove to excel the others in output. It was the day of converter records. One reason for this competition was doubtless personal emulation among the managers. When the Bessemer process was introduced in this country, soon after the Civil War, it attracted a number of ambitious young men who were associated with certain plants from their inauguration. Since the industry was young and rapidly developing they naturally kept a keen eye upon what their competitors were doing. Early in 1874 the Troy Works reported the largest product ever attained by a five-ton plant in twenty-four hours, or just under 268 tons of ingots with fifty blows. A weekly product of between 950 and 1,000 tons had been attained at both Troy and Cambria, and the North Chicago Rolling Mill Company produced more than 4,000 tons of metal in a single month. Steel men argued at this time that if American makers were to limit their product per plant to the foreign standards they could not survive. It was increased production with the same amount of labor that enabled them to hold their own against their European rivals, who paid lower wages.[1]

By the following year the monthly product of the larger plants increased about 50 per cent, to 6,000 tons or more, without any addition to their machinery. The Pennsylvania Steel Company cast a single ingot weighing 12 tons.[2] When, in 1877, the Edgar Thomson Works made over 8,000 tons a month with two converters, it was asserted that no foreign works could equal this record. Yet the North Chicago Rolling Mills made 8,393 tons the following January, and only a little later the new works at Scranton exceeded even that figure. American converters were smaller than those abroad, and it is possible that a few foreign works exceeded the American production for that reason, although this was disputed. By the end of the decade several plants were making approximately 3,000 tons a week,

[1] Bridge, *Inside History of the Carnegie Steel Company*, 93; American Iron and Steel Association, *Bulletin*, VIII, 61, Feb. 19, 1874; VIII, 217, July 16, 1874; VIII, 341, Nov. 12, 1874.

[2] American Iron and Steel Association, *Bulletin*, X, 117, Apr. 12, 1876.

thus tripling with practically the same equipment their output six years previously.[3]

About this time somewhat larger converters came into use and other improvements were made which speedily brought up these figures to a higher point. It was generally believed, however, that 15,000 tons would represent the limit of economical production. Great esprit de corps was aroused among the workmen of different plants, who developed a sporting interest in their records. An incidental result was to substitute the three-shift for the two-shift day without materially reducing the earnings of the men. Since the limit to production was determined by the time taken to get the ingots away from the casting-pit and the new molds set in position, the increase in the number of blows was not at the cost of quality.[4]

AMERICAN BESSEMER PLANTS

As we have pointed out elsewhere, American steel makers at once struck out on an independent line, modifying their plants to meet local conditions until typical works in this country varied considerably from those abroad. Numerous new processes were recorded in the iron and steel literature of the day, though few of these left a permanent imprint on the history of steel technology. In 1877 experiments were made at St. Louis with forging and rolling steel scrap in piles, as iron bars had been rolled and welded in our rail mills for a quarter of a century and more. At that time scrap steel was in little demand, selling for about the price of pig iron. The same year the Joliet Company experimented with a new method of lining its converters, which added fully 50 per cent to the permanence of the converter bottoms. About this time the so-called straight-nosed converter was also invented at the same place. Another important American improvement was the Jones mixer, which made it possible to combine molten metal from different furnaces before introducing it to the converters.[5]

For fifteen years the typical American Bessemer plant was designed along essentially the lines adopted by A. L. Holley when he installed the first permanent apparatus at Troy; but between 1879 and 1882, a notable change took place in plant arrangement, with the object of enlarging output and saving labor. The so-called American lay-out had hitherto consisted of two converters of about five-tons capacity, side by side, served by a single ladle crane. Improvements in practice had raised the capacity of such a plant from about 10,000 long tons per annum in 1868 to more than 14,000 long tons a month twelve years later. This was accomplished mainly by increasing the number of heats, and the latter was rendered possible by several improvements, chief among which were better cupola practice, the

[3] American Iron and Steel Association, *Bulletin*, XI, 187, July 11, 1877; XII, 60, Mar. 13, 1878; XII, 179, 180, Aug. 7, 1878; XII, 253, Oct. 30, 1878; XIV, 261, Oct. 20 and 27, 1880.

[4] American Iron and Steel Association, *Bulletin*, XV, 36, Feb. 9, 1881; XV, 121, May 18, 1881; XV, 292, Nov. 16, 1881.

[5] American Iron and Steel Association, *Bulletin*, XI, 76, Mar. 14, 1877; XI, 201; Aug. 1, 1877; Bridge, *Inside History of the Carnegie Steel Company*, 78, 79.

removable converter bottom, the use of a more refractory lining, the perfection of the hydraulic-crane system for handling ingots, and the increased skill and better team work of the operatives. As just mentioned, the limit to the output of such a plant was set by the facilities for removing ingots from the casting pit.[6]

The changes which now occurred were in two directions: converters were enlarged and their number was increased to permit the use of two or more ladle cranes, so that the three and four-converter plant with seven-ton to ten-ton converters speedily became the standard arrangement in America. Among the other improvements already introduced were taking the metal directly from the blast furnace instead of running it into pigs and reheating in a cupola, the use of two-high reversing mills instead of three-high mills for either blooming or rail rolling, and rolling rails directly from the ingot without shearing or reheating the bloom. The most radical changes from the old method were initiated in the West. The North Chicago Rolling Mills, which had a larger capacity than any three-converter plant previously built, looked remarkably small to a man familiar with foreign or eastern works, because they dispensed with a large portion of what was hitherto supposed to be necessary machinery. The practice of taking pig metal directly from the blast furnace to the converter had already been introduced at several places abroad, but the other improvements were entirely original to America. Ingots were removed from the molds before the interior had cooled and were reheated to give a uniform temperature, in a Siemens furnace, whence they passed directly to the blooming mill and the rail mill.[7]

Early in 1883 the Edgar Thomson Steel Works began to transport their molten iron in tanks directly from the blast furnace to the converters, and the Cambria Iron Company soon followed suit. About this time the practice of blowing the converters with a combination of air and steam was introduced both at these works and at South Chicago. Apparently the new process was adopted independently by each plant, but at Chicago first. It was claimed that this made possible better control over the temperature of the charge and obviated the use of scrap steel and clippings in the converter.[8]

About 1884 the Clapp-Griffiths process for manufacturing low silicon steel suitable for rolling in an ordinary iron mill was introduced at Pittsburgh. It required a less expensive plant than the ordinary Bessemer process, the operation being performed in small stationary converters in which the molten metal was subjected to a blast injected above the bottom, and not at the bottom as in the ordinary Bessemer tip-converter. Within two years 8 works embracing 13 converters using this process were in op-

[6] American Iron and Steel Association, *Bulletin*, xvi, 309, Nov. 15 and 22, 1882.

[7] American Iron and Steel Association, *Bulletin*, xvi, 298, Nov. 8, 1882.

[8] American Iron and Steel Association, *Bulletin*, xvii, 12, Jan. 17, 1883; xvii, 332, Dec. 5, 1883; xviii, 3, Jan. 2, 1884.

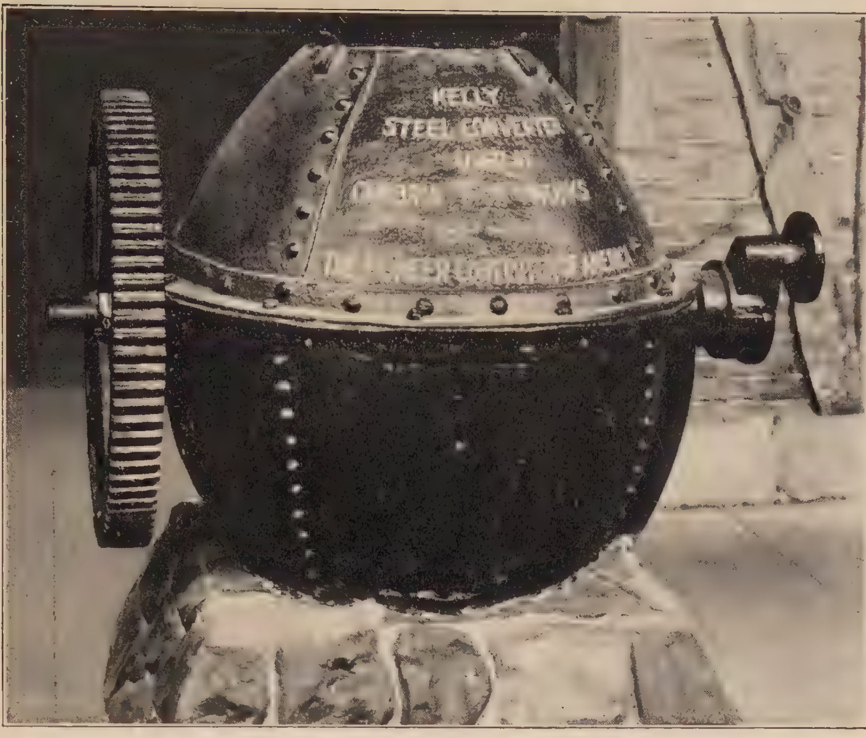

FIG. 1. A Kelly Converter of the Sixties

FIG. 2.—A Modern Bessemer Converter

Courtesy of the Bethlehem Steel Co.

eration or under construction. It proved particularly suitable for making steel for nail plates and wire rods.[9] In 1888 an experimental electric crane installed by the Otis Iron and Steel Company of Cleveland and having an electro-magnet capable of lifting a weight of 800 pounds was mentioned as a novelty.[10]

OPEN-HEARTH FURNACES

No such spirit of enterprise as characterized American Bessemer engineers was exhibited in the open-hearth industry for nearly twenty years after its introduction in this country. But about 1885 furnace improvements were introduced in the United States which enabled makers to produce this steel in larger quantities than heretofore, and consequently at a lower price. Ten years before this date open-hearth steel was already made in Germany, France and Scotland, at about the same cost as Bessemer steel, and rails were rolled of this material. No corresponding development occurred in the United States until much later, partly because the Bessemer process, which was well adapted to making the rail steel principally consumed in this country, had an initial lead and was favored by fuel and ore conditions, and partly because patents were an obstacle in the way of open-hearth expansion. At this time American plants using the latter process were mostly small and based their reputation on some fancied peculiarity of their product.[11]

BASIC AND ACID PROCESSES

The history of the basic process in America during this period is largely a record of patent litigation. Diversification of the steel industry had to wait upon better control over the chemical processes by which this metal was made and the consequent possibility of employing in its manufacture a wider range of raw materials. The acid Bessemer process, which was for several years the only one used in this country, requires pig iron with a low phosphorus and sulphur content. In the basic Bessemer process, phosphorus, instead of being a disadvantage, is a benefit, because it is by the combustion of phosphorus that the heat which keeps the metal molten in the converter is generated. In the acid Bessemer process the combustible element is mainly silicon. The products of combustion—silicon oxide in one case and the oxides of phosphorus in the other—in each instance combine eventually with the furnace lining. If an acid lining—the oxide of a metalloid—is used, and silicon is burned, this by-product is a kind of sand. If a basic lining—an oxide of a metal—is used, the product is a phosphate, which is valuable in itself, since it makes an excellent fertilizer. In the open-hearth process it was not important to have either

[9] American Iron and Steel Association, *Bulletin*, XIX, 105, Apr. 22 and 29, 1885; XIX, 125, May 13, 1885; XIX, 300, Nov. 11, 1885; XX, 228, Sept. 1, 1886; XXI, 77, Mar. 23, 1887.

[10] American Iron and Steel Association, *Bulletin*, XXII, 117, Apr. 11, 1888.

[11] American Iron and Steel Association, *Bulletin*, IX, 107, Apr. 16, 1875; IX, 281, Sept. 17 and 24, 1875; XVI, 107, Apr. 12 and 19, 1882; *Mineral Industry*, II, 377–378.

silicon or phosphorus, since the heat employed came from outside the furnace charge. This made it possible to employ a greater variety of iron for making steel in an open-hearth furnace than in a Bessemer converter, no matter whether the acid or the basic process was employed.

Basic steel manufacturing received its first impulse from a report rendered by S. G. Thomas and P. C. Gilchrist at a meeting of the British Iron and Steel Institute held at London in May 1879. Previous to that date it had not been possible to make good steel from ores containing an appreciable amount of phosphorus, and three-fourths of the ores of Great Britain suffered from this disadvantage. That country was therefore likely to become dependent upon imported materials for the expansion of its steel industry. The period was just approaching when local non-phosphoric ores no longer filled the need.[12]

In 1881 the Bessemer Steel Company, Ltd., the organization which had owned the original Bessemer and Kelly patents, purchased the rights to the Thomas process for America.[13] Two years later the Pennsylvania Steel Company altered its old Bessemer plant, which was idle because superseded by a new three-converter plant, so as to adapt it to making basic steel. Excellent material for linings was obtained in the neighborhood, and pigs made from highly phosphoric local ores were used. The first run was made on May 7 of that year and as the experiment proceeded the result soon proved commercially satisfactory.[14] Joseph Reese of Pittsburgh, who occupied much the same position with reference to this discovery that William Kelly occupied with reference to the Bessemer process, at once brought suit for violation of a conflicting patent previously issued to himself. This litigation was watched with interest, especially in the South, where it was believed the future of the steel industry depended on ability to use these patents without paying heavy royalties; but a delay in getting a final judgment from the court, which extended to several years, combined with the fact that the steel industry of America was depressed during the middle eighties, postponed the general introduction of the process.[15]

The first basic open-hearth furnace began operation in January 1886 at the works of the Otis Steel Company in Pittsburgh. The furnace bottom was made of magnesite imported from Austria. But after about 1,000 tons of ingots had been made, the Company, finding the product not entirely satisfactory, returned to the acid process.[16] Nevertheless the controversy over patents, accompanied by bitter attacks upon the Bessemer Steel Company, Ltd., which was charged with trying to prevent their use in order to maintain a monopoly for the existing acid plants, continued to

[12] American Iron and Steel Association, *Bulletin*, XXXVIII, 130, Sept. 10, 1904.
[13] American Iron and Steel Association, *Bulletin*, XV, 92, Apr. 13, 1881; *Cf.* A. S. Holly, in American Society of Mechanical Engineers, *Transactions*, I (not paged consecutively).
[14] American Iron and Steel Association, *Bulletin*, XVII, 132, May 16, 1883.
[15] American Iron and Steel Association, *Bulletin*, XX, 25, Feb. 3, 1886.
[16] American Iron and Steel Association, *Bulletin*, XXXI, 228, Oct. 10, 1897.

rage.[17] It was not until 1888, some seven years after the patents were acquired, that basic open-hearth steel was first regularly produced on a commercial scale in America, at the Homestead Works near Pittsburgh. Two years later this firm added eight furnaces to its existing plant, thereby doubling its capacity. The Pennsylvania Steel Company had by this time introduced the duplex process, employing its acid Bessemer converter to decarbonize its iron and completing the process in open-hearth furnaces. The same practice was adopted about this time by the new steel works erected in the South.[18]

The introduction of new methods of manufacture raised the question of revising the nomenclature of iron and steel. In 1876 a committee appointed by the American Institute of Mining Engineers reported on this subject, recommending certain standard definitions and terms to be employed in trade contracts and professional literature. This report provoked a vigorous debate and its proposals were never accepted by iron masters and dealers. A little later the same question arose in connection with the definition of steel in the tariff and was settled by Treasury decisions, which naturally were final so far as import trading was concerned. Subsequently the classification and definition of steel and iron were occasionally discussed in trade papers and association reports but no attempt was made to foist a hard and fast nomenclature upon the trade. Indeed, it was felt that processes were changing so rapidly that no suitable trade terms could be devised, and by the early eighties the practice of naming steel after the process by which it was produced was so thoroughly established that it was not subsequently questioned.[19]

STEEL VERSUS IRON

During these twenty years steel was steadily usurping the place of iron, although the latter held its own better in America, where the Bessemer process was so dominant, than it did abroad, where a greater variety of methods was employed with a consequent diversity of products. In 1873 Bessemer steel was made into wagon tires, carriage and car springs, and certain grades of tools including augurs, and screws. It was also used to some extent in the manufacture of agricultural implements and car wheels.[20] Many prophesied that it would almost immediately supplant puddled iron in most of the uses for which the latter was employed, but as we have seen this transition did not occur with the speed predicted. As long as the demand for rails was increasing fast enough to absorb the capacity of new

[17] American Iron and Steel Association, *Bulletin*, XXI, 124, May 11, 1887; XXII, 300, Oct. 3 and 10, 1888; XXIII, 177, July 3, 1889; XXIV, 325, Nov. 12, 1890; XXV, 20, Jan. 21 and 28, 1891.

[18] American Iron and Steel Association, *Bulletin*, XXIV, 316, Nov. 5, 1890; XXVI, 51, Feb. 24, 1892.

[19] American Iron and Steel Association, *Bulletin*, X, 300, Nov. 8 and 15, 1876; X, 301, Nov. 8 and 15, 1876; X, 309, Nov. 22, 1876; XI, 137–139, May 23, 1877; XII, 132, June 5, 1878; XV, 139, June 1 and 8, 1881; XXVI, 11, Jan. 14, 1891; XXXIV, 35, Feb. 15, 1900.

[20] American Iron and Steel Association, *Annual Report of Secretary*, 1875, 53.

Bessemer works, there was no incentive for the owners of the latter to press their product into other and smaller markets; and, partly because they specialized so largely in this one field, our steel makers did not turn out a product as satisfactory for many uses as wrought iron.[21]

The comparatively small amount of open-hearth and Siemen's-Martin steel produced was also absorbed in a few special lines. Not only did iron hold its own, but about 1879 there was some discussion of resuming the use of iron for rails, although both technical and economic considerations rendered this proposal visionary.[22] In 1883 the North Chicago Rolling Mill Company began making at its South Chicago plant a special soft weldable steel, to supply the large local market for such a metal afforded by the makers of agricultural implements and vehicles.[23] By this time steel was extensively used for boiler plates. The production of steel wire greatly exceeded that of iron wire; steel plates were being substituted for iron plates in shipbuilding; steel car axles and shafts and forgings were becoming common; but in none of these fields had steel supplanted iron sufficiently to cause an absolute reduction in the use of the latter. The demand for puddled iron continued to grow because the market was expanding fast enough to absorb both steel and iron together.[24]

In 1885 the Government, as a result of an unfortunate experience with steel shafts, abandoned the latter and substituted iron in the Navy specifications. At this time, as in 1879, there seems to have been a general reaction in favor of the use of iron for many purposes under the impression that steel was unreliable and subject to unpredictable failures at critical times and places.[25] Steel makers, however, were steadily improving the quality of their product, while the quality of the wrought iron in the market remained unchanged. Furthermore, the cost of making steel was falling, while the cost of making puddled iron was stationary or rising. So both technical and economic considerations favored the growing use of the former metal.[26]

NEW STANDARDS AND ALLOYS

A not unimportant influence hastening the improvement of steel making in the United States was the system of inspection established by the Navy Department for controlling the quality of metal delivered under government contracts. Although steel manufacturers at first resented this supervision, which was introduced in the middle eighties when the Government set about building what was known as the "New Navy," they soon realized

[21] American Iron and Steel Association, *Bulletin*, XII, 281, Nov. 27, 1878; *cf.* Bridge, *Inside History of the Carnegie Steel Company*, 85–87.

[22] American Iron and Steel Association, *Bulletin*, XIII, 227, Sept. 10, 1879.

[23] American Iron and Steel Association, *Bulletin*, XVII, 81, Mar. 28, 1883.

[24] American Iron and Steel Association, *Bulletin*, XVII, 233, Aug. 29, 1883; XVII, 257, Sept. 19, 1883.

[25] American Iron and Steel Association, *Bulletin*, XIX, 59, Mar. 4, 1885; XIX, 121, May 13, 1885.

[26] *Cf.* American Iron and Steel Association, *Bulletin*, XXVI, 165, June 8, 1892.

that the standardization thus forced upon them was to their advantage. Within two or three years the quality of ship plates, rivets and steel castings had been raised to a point considered impossible when Government inspection was established. This influence made itself felt not only in the East but also in the West, where the Pacific Rolling Mills at San Francisco turned out steel plates exceeding even the severe tests set by the Navy.[27]

Among the improvements that were suggested or encouraged by Navy requirements was the employment of various alloys for hardening steel. Chrome steel, which was discovered in France in 1821, was manufactured in the United States soon after the Civil War. In 1876 a white chromium alloy was produced at Brooklyn from what were called Baltimore ores, probably from the vicinity of Lancaster.[28] Much more important, at least from the naval standpoint, was the manufacture in America of nickel steel for armor plates after a process which had been developed at the Creusot works in France. This invention was patented as early as 1876. Ten years later the French process was purchased by the Bethlehem Steel Works, but the first nickel steel plates actually produced in this country were made for the Navy Department in 1890 at the Homestead Works near Pittsburgh. The same year the Bethlehem Works, whose managers had been busy ever since 1886 "creating the large plant required" to make nickel steel armor plates, were likewise ready to begin operations.[29]

About the same time Henry A. Harvey, in the course of experimenting with a process for hardening the surface of cast-iron bolts and nuts so as to give them the toughness of steel, hit upon a process for tempering low-grade Bessemer steel so as to give it many of the qualities of crucible or cast steel. The first patents for this method were granted in 1888. Works were established at Jersey City and afterward moved to Newark, where the Harvey armor-plate process was developed.[30]

STEEL CASTING

Defects in steel, which explained the lack of reliability that retarded its substitution for iron, were generally attributed to flaws caused by the generation of gases within the ingots during the process of cooling, or to spaces formed during the contraction of the metal by reason of the outer skin's first becoming solid and then refusing to follow the interior portion of the still heated ingot during its subsequent contraction. In order to remedy these defects various methods for keeping the ingot under pressure during the cooling process were devised. The most successful of these was the application of high-pressure steam in the ingot mold. This system was in

[27] *Iron Age*, XXXIX, 17, June 16, 1887, quoted in American Iron and Steel Association, *Bulletin*, XXI, 178, July 6, 1887.

[28] American Iron and Steel Association, *Bulletin*, XII, 203, Sept. 4, 1878.

[29] American Iron and Steel Association, *Bulletin*, XXIV, 361, Dec. 24, 1890; XXIV, 292, Oct. 15, 1890; XXV, 117, Apr. 22, 1891; *Engineering Magazine*, XII, 838–845, Feb. 1, 1897.

[30] American Iron and Steel Association, *Bulletin*, XXII, 221, July 11 and 18, 1888; XXVII, 269, Sept. 6 and 13, 1893.

use at the Edgar Thomson Works before 1880. It was discovered that by varying the degree of pressure, the quality of the steel produced might be modified, a higher pressure producing a milder metal.[31]

The statistics of steel imports from 1873 to 1883 indicate that the quantity of high-grade steel imported from Great Britain was stationary or decreasing in spite of the rapid expansion of manufactures in which it was employed.[32] Steel castings were probably first made in America in 1867, and were soon employed extensively, especially in the manufacture of agricultural machinery.[33] During the eighties steady progress was made in the technique of casting this metal, with the result that it replaced iron forgings for an increasing number of uses in which the latter had previously been employed. In 1888 a steel casting weighing 150 tons was made at Bethlehem; and the stem and stern frames of warships with their branching connections were cast of steel at much less cost than when forged.[34] Three years later the Midvale Steel Company opened a new plant especially devoted to steel founding, with a capacity of 100 tons a day. This firm had already been making steel castings for twenty years and was at one time the only producer of them in America. The Pittsburgh Steel Casting Company rivaled the Midvale Company in this field. As early as 1883 the Cambria Works cast from open-hearth steel some of the heaviest shafts ever made in this country.[35]

STEEL FORGING

Nevertheless improvements in forging kept pace with those in casting steel. During the first third of the century the heavier shafting used for water wheels and other power connections of New England factories was made of wood with wrought iron gudgeons easily forged by light trip hammers. No heavy forgings were required for the slow-running walking-beam steam engines used for motive power during the middle decades of the century. Wrought iron shafts could be built up by welding together several pieces of iron with the light trip hammers still in use. Between 1860 and 1870, when the Bessemer process began to supply steel in greater quantities, European plants speedily adopted this material for heavy forgings, and during twenty years thereafter their machinery was superior to our own. A steel shaft can not be forged by welding, but must be made from a single ingot and compacted under a powerful hammer or by a hydraulic press. The failure of several American steamship shafts in the early eighties, which as we have just seen caused the Navy Department for a time to return to wrought iron shafting in its specifications, was due to imperfect forging.

[31] American Iron and Steel Association, *Bulletin*, XIV, 242, Oct. 6, 1880.
[32] American Iron and Steel Association, *Bulletin*, XIX, 212, Aug. 12, 1885.
[33] American Iron and Steel Association, *Bulletin*, IX, 106, Apr. 16, 1875; XL, 22, Feb. 1, 1906.
[34] American Iron and Steel Association, *Bulletin*, XXI, 189, July 13, 1887; XXII, 213, July 4, 1888.
[35] American Iron and Steel Association, *Bulletin*, XVII, 300, Oct. 24 and 31, 1883; XXIV, 285, Oct. 1 and 8, 1890; XXV, 386, Dec. 30, 1891.

But when our mills attempted again to make wrought iron shafting, so much steel had found its way into the scrap heaps of the larger works, where it was impossible to distinguish it from iron, that it became practically impossible to eliminate it from built-up forgings, where it caused weak spots and points of fracture.[36]

American steel shafting was used on western river boats as early as 1878. The first shaft of this kind was forged at Pittsburgh, but a company at Nashua, New Hampshire, soon entered this field.[37] In 1881 a 17-ton steam hammer was erected at the Black Diamond Steel Works in Pittsburgh, which was considered a remarkable piece of machinery at the time. This plant manufactured a 10-ton roll for a sheet mill, which was said to be the first hammered roll made in this country, an instance where a forging replaced cast steel. Two years later, in 1885, a much larger hammer was erected at Cleveland, chiefly to forge steamship shafts. Nevertheless as late as 1887 the Cramps and the Union Iron Works at San Francisco ordered the shafting for their vessels from Whitworth's in England and Krupp's in Germany. Even the German shafting was not always dependable, and in 1888 there is record of an iron shaft being forged at Pittsburgh on a river steamer of a Krupp steel shaft which had broken after three years service.[38]

During the later eighties when American steel works were placing their forging equipment on a par with the best in Europe, considerable machinery was imported from abroad for this purpose. Both the Bethlehem Company and the Carnegie Works went to foreign makers for their hammers and presses. Hammers ranging from 80 to 150 tons were at this time in use at the Creusot Works in France, the Cockerill Works in Belgium, and at Krupp's in Essen, the last being the heaviest of the three. When the Bethlehem Company installed what was reported to be the largest steam hammer in the world—though this is doubtful—in 1891, it used the design of the Creusot Works. This hammer had a stroke of 125 tons. At this time France had an overwhelming array of big hammers, because its steel makers had been encouraged by continuous government contracts to install such machinery. Even England fell behind its competitor across the Channel in this special kind of equipment.[39]

Fortunately for Great Britain, a different system of forging had been developed there, which gave its works a capacity in excess of those of its neighbor. The British substitute for the hammer was the hydraulic press—silent, slow-working, but irresistible in its action. The objection to a hammer is not only that its blows disturb and injure neighboring machinery,

[36] New England Cotton Manufacturers' Association, *Transactions, Niagara Falls Meeting*, 1901, 267–279.

[37] American Iron and Steel Association, *Bulletin*, XIII, 84, Apr. 9, 1879; XIII, 275, Oct. 29, 1879.

[38] American Iron and Steel Association, *Bulletin*, XVII, 69, Mar. 7, 1883; XVII, 245, Sept. 5, 1883; XIX, 195, July 22 and 29, 1885; XXI, 29, Feb. 2, 1887; XXII, 117, Apr. 11, 1888.

[39] American Iron and Steel Association, *Bulletin*, XXII, 109, Apr. 4, 1888; XXII, 149, May 9, 1888; XXV, 201, July 8 and 15, 1891.

but that its effect is instantaneous. The force of a hammer stroke is absorbed to a great extent on the surface of the forging and sometimes causes the latter to pipe or become hollow and unsound in the center. A press avoids this fault.[40] But both the hammer and the hydraulic press had their place in a great steel plant. In 1889 the Bethlehem Works exhibited at Boston shafting of fluid-compressed steel and also tubes for 10-inch artillery. By that time these works were supplying shafts for our new naval vessels. In 1893 the same company furnished the 45-ton steel shaft that formed the axis of the Ferris wheel at the World's Fair in Chicago, which was reputed to be the largest steel forging thus far made in this country. The same year the Carnegie Company imported from England for its armor plate works at Homestead what was considered the largest hydraulic press in the world. It had a capacity of 16,000 tons.[41]

Another improvement of this period was electric welding, developed from an accidental discovery by Professor Elihu Thomson, who observed that the wires of an induction coil which he was using to illustrate a lecture in Philadelphia had melted together from overheating. Following up this discovery, Professor Thomson patented in 1886 a method for general electric welding and immediately organized a company in Boston to manufacture apparatus for that purpose. The first commercial machine was put in operation at Roeblings Iron Works at Trenton in 1888. Soon afterward the process was applied to joining rails, especially those used in electric traction, and a special plant was built for this purpose at Johnstown, Pennsylvania, where the Thomson process was used extensively. This company, which was organized by Tom Johnson of Cleveland, was also the pioneer in the manufacture of the girder rail for street railways, and one of its machines was capable of welding steel ends five inches square.[42]

STEEL ROLLING

Among the motives for the introduction of the Bessemer process in America may have been to supply a better material for armoring ironclads; for, as we have seen, the Navy Department suggested the desirability of this while the Civil War was still in progress. But that market had temporarily vanished by the time the first works went into operation and the real demand upon which the industry was founded was afforded by the railways. Consequently Bessemer steel was first extensively used in the United States in rolled shapes. Nevertheless the use of rolled steel in other forms than rails made slow headway. This was due largely to the prejudice to which we have already referred in favor of wrought iron as the more

[40] American Iron and Steel Association, *Bulletin*, XXIII, 147, June 5, 1889; XXV, 26, Feb. 4, 1891.

[41] American Iron and Steel Association, *Bulletin*, XXIII, 353, Dec. 25, 1889; XXVII, 91, 93, Mar. 22 and 29, 1893.

[42] American Iron and Steel Association, *Bulletin*, XXV, 107, Apr. 15, 1891; XXV, 221, July 29, 1891; XXVI, 66, Mar. 9, 1892.

reliable material. The slowness with which the public overcame its distrust of steel is illustrated by the tardiness with which that metal was adopted for boiler plates. Although other companies entered this field earlier, and a steel boiler made at Fitchburg, Massachusetts, was exhibited at the Boston Mechanics' Fair in 1874, it was not until 1878 that the Juniata Works, which had abandoned the manufacture of iron boiler plates soon after the Civil War on account of the competition of inferior goods, felt justified in resuming their production with open-hearth steel. That year they erected a small Siemens-Martin furnace and, after testing the product for two years in a variety of other uses, began about 1880 to roll plates for boilers, which were used in the plants of several large furnace companies in the vicinity as well as on Ohio steamers.[43] In the seventies a Pittsburgh firm rolled plates 33 feet long and $\frac{3}{16}$ of an inch thick for a Delaware River shipbuilder. Similar plates were made at Cleveland and Chicago for the use of the shipyards on the Great Lakes.[44]

About the close of the Civil War, the demand for heavier plates for armoring monitors encouraged the erection of larger mills in this country. The Soho Works at Pittsburgh in 1864 furnished the Government with armor plates from 3 to 12 inches thick and up to 20 feet in length. For several years after the ending of hostilities there was little demand for iron in this form and the mills were used for other purposes. But when the Government embarked on warship construction in the middle eighties it advertised for heavier armor plates of steel than had hitherto been manufactured in America, and the prospect of this and further contracts caused the erection of large plate mills at Homestead.[45]

Sheet steel may have been rolled by the sheet-iron makers of the Wilmington and the Baltimore district at a comparatively early date, and in the late eighties an Ohio manufacturer succeeded in making sheets resembling Russian iron from low carbon steel. But the great stimulus was given to this branch of rolling-mill work by the new market created by the domestic tin-plate industry. This came at a fortunate time for the nail makers of Wheeling and the neighboring section of the Ohio Valley; because the demand for nail plates diminished rapidly with the substitution about 1890 of wire nails for the cut nails previously in use, and several companies affected by this change converted their plants into establishments for rolling black plates. The same market is to be credited with an important technical improvement originated and perfected, it is said, by Edwin Norton, a tin-plate manufacturer of Chicago. This was a successful process of rolling fluid metal, with which Sir Henry Bessemer had experimented more

[43] American Iron and Steel Association, *Bulletin*, xv, 257, Oct. 12, 1881; *cf. id.*, xvii, 233, Aug. 29, 1883.

[44] American Iron and Steel Association, *Bulletin*, viii, 284, Sept. 24, 1874; xii, 222, Sept. 18 and 25, 1878; xxv, 362, Dec. 9, 1891.

[45] American Iron and Steel Association, *Bulletin*, xi, 195, July 18 and 25, 1877; xxi, 3, Jan. 5 and 12, 1887.

than thirty years before.[46] A remotely analogous improvement was introduced at the Edgar Thomson Steel Works as early as 1883 for making steel rails. This consisted in placing the ingots as soon as they were cool enough to leave the mold, in soaking pits where they were brought to a uniform degree of heat by their own temperature and rolled without reheating.[47]

Between 1884 and 1888, George Simonds, a manufacturer of Fitchburg, Massachusetts, invented a method of rolling metal between dies affixed to two flat surfaces moving in opposite directions. In this way he was able to give metal any desired form—a square, a sphere, a screw, a threaded bolt, an axle, or a spindle. This device made it possible for one man to manufacture 2,000 perfect spindles a day, while previously only 400 imperfect spindles, which required subsequent adjusting and truing, could be made under a forge.[48]

[46] American Iron and Steel Association, *Bulletin*, XXIII, 209, Aug. 7, 1889; XXV, 3, Jan. 7, 1891; XXV, 370, Dec. 16, 1891; XXVII, 109, Apr. 12, 1893.

[47] American Iron and Steel Association, *Bulletin*, XVII, 213, Aug. 8, 1883; *cf. id.*, XXV, 389, Dec. 30, 1891.

[48] American Iron and Steel Association, *Bulletin*, XXII, 68, Feb. 29, 1888.

CHAPTER XXIV

ORGANIZATION IN THE IRON AND STEEL INDUSTRY

LABOR UNIONS AND STRIKES

In certain departments of the iron and steel manufacture labor was strongly organized, and in those sections of the country where the principal works were situated the vicissitudes of the industry were associated in no slight degree with labor conditions. To be sure we hear little of strikes among metal miners and furnace men, partly because the employes in these branches of the industry included many foreigners of diverse and often discordant nationalities who were not much above the scale of unskilled casual workers. Until the organization of the Knights of Labor, attempts at combined action in this group of occupations were only sporadic and local. But strikes in the anthracite mining districts and the Connellsville coke fields interrupted furnace operations at one time and another, though never simultaneously, in the whole region between Albany, New York, and Birmingham, Alabama.

During the earlier years of this period labor conflicts were most frequent, protracted and widespread geographically among the puddlers. Most of these workers were Scotch and British immigrants or men trained under their supervision, and all of them were imbued with the trade-union tradition of the older country. Ever since the introduction of puddling in America it had been the custom to pay puddlers and boilers, as it had been to pay forge men who preceded them, by the ton of product; and about the time of the Civil War—tradition has it in 1864—the sliding scale was introduced. This was an arrangement by which the puddler was paid at a piece rate, which rose and fell above a stated minimum, with the price of iron. If the price of bar iron fell below a certain quotation fixed in the agreement between the employer and his men, wages remained stationary at the lowest point provided in the scale, but if iron rose above that quotation, wages increased by a certain increment for every advance in its market price.[1] This form of payment implied a contract, or at least an understanding, between the employes as a body and an individual employer or a group of employers; and that contract was necessarily backed by an organization.

[1] Such a scale is printed in American Iron and Steel Association, *Bulletin*, XIII, 155, June 18 and 25, 1879; XVII, 73, Mar. 14 and 21, 1883; XVIII, 125, May 14, 1884.

The organization thus implied was not confined to the workers. Manufacturers of bar iron as well as the men in their pay soon saw the necessity of united action. So employers' associations sprang up in the principal iron-making centers. The leading group of this sort was in the Pittsburgh district, although its membership at times included many of the important manufacturers in the Ohio Valley as far as Cincinnati, at Youngstown, and in the Great Lake cities.[2] At first the puddlers, then the steel workers, formed corresponding alliances, and finally the Amalgamated Association of Iron and Steel Workers was organized and remained for many years an important factor in determining wage rates and other labor conditions. These unions influenced not only the continuity of operation of the great iron and steel works of the western district, but also to some extent the entire organization of the industry.[3] They were not so important east of the Alleghenies, where labor conditions continued to vary considerably from those in the Pittsburgh district and farther west. Neither were they a power in the growing iron and steel region of southern Tennessee and northern Alabama.

About the middle eighties a rival of the Amalgamated Association appeared, with which it had a brief but bitter struggle to control the industry. This was the Knights of Labor, which was organized upon an entirely different principle from the older society. The latter was a union of skilled workers. Its power depended largely upon the fact that its membership consisted of men who, on account of possessing special skill in conducting a certain stage of manufacturing iron and steel, could not be replaced by ordinary workers if they withheld their services. It might thus happen that by ordering a score or so of men—for instance, the heaters—to stop work, the Amalgamated Association could halt operations throughout an entire plant and throw hundreds of men out of employment. The Knights of Labor, on the other hand, sought to enroll in their ranks all the employes engaged in the industry, from the ignorant immigrant who sold only muscle and physical endurance to his employer, to the highest paid heater and roller man. These two unions had a trial of strength in 1887 at Mingo Junction—since celebrated for other reasons in labor annals—from which the Amalgamated Association emerged victorious,[4] and the latter continued to exercise an influence, at times approaching control, over labor conditions affecting its members in the western district until about the end of the century.

WAGES

Following the panic of 1873 came the period of languishing markets, falling prices and curtailed or stationary production, which we have already described. Naturally, this was accompanied by an effort on the part of

[2] American Iron and Steel Association, *Bulletin*, XVI, 149, May 31, 1882; XVII, 73, Mar. 14 and 21, 1883; XVIII, 125, May 14, 1884.

[3] *Cf.* Bridge, *Inside History of the Carnegie Steel Company*, 186.

[4] American Iron and Steel Association, *Bulletin*, XXI, 59, Mar. 2 and 9, 1887; XXI, 75, Mar. 23, 1887.

employers to reduce their production costs, mainly by the simplest and most obvious device of lowering wages. Several labor conflicts occurred between 1873 and 1875: A strike of the heaters at the rolling mills in Chicago and Milwaukee in 1873; a strike at the Pennsylvania Steel Works and among the Troy puddlers the following year; and a puddlers' strike at Pittsburgh in 1875, which was made notable in labor history by the employment of colored puddlers imported from the old iron town of Richmond, Virginia.[5] All these disputes were won by the employers.

In most occupations, except puddling, the earnings of employes tended to rise if the workers could keep their piece-work scale unchanged. The explanation for this was that the output of iron and steel works was rapidly increasing on account of the introduction of improved machinery, so that at the same rate per ton the men could make more money. And in fact earnings did increase steadily throughout this period, though not quite in the same ratio as output. Naturally, however, employers constantly endeavored to lower the piece-work rate in order to secure additional profit from the expensive machinery they installed, while the workers, if they did not ask for a higher scale, almost invariably resisted, even at the cost of a strike, an attempt to modify that scale to their disadvantage. Had the iron and steel industry been technically stationary during this period, the relations between labor and capital might have been less stormy. We can not make this generalization with perfect assurance, however, because in the branch of the iron industry where no appreciable improvements occurred to increase the workers' output, namely puddling, there were repeated conflicts between employers and employes. What the puddler did gain as time went on was mainly more regular employment, and therefore larger annual earnings, though at the cost of more continuous labor.

Bar rolling may be used as an example to illustrate the tendency just suggested. During the six years ending with 1880 rates of pay for rollers fluctuated, but in 1881 they were fixed on a basis of 70 cents a ton minimum, which remained in force until 1885 when there was a temporary reduction. The 70-cent rate was restored within a few months, however, and except for a brief interval in 1887 continued in effect until 1892. Averaging the rate for these 18 years, the variation from 70 cents did not exceed two-thirds of a cent a ton, although the price of iron ranged at different dates from a maximum of nearly $90 to a minimum of less than $36 a ton. Meanwhile, however, a roller's output, on account of mechanical improvements, rose from between 12 and 15 tons to 25 and 30 tons, reaching a maximum in the best mills of 60 tons. In other words, while the price of iron varied widely and was lower at the end of the period than at its beginning, the earnings of workers in this department rose pretty constantly, averaging in 1893 nearly or quite three times their amount two decades earlier.[6]

[5] American Iron and Steel Association, *Bulletin*, VII, 413, Aug. 27, 1873; VII, 418, Sept. 3, 1873; VIII, 212, July 9, 1874; VIII, 229, July 23, 1874; VIII, 324, Oct. 29, 1874; IX, 37, Feb. 12, 1875; IX, 68, Mar. 12, 1875.

[6] American Iron and Steel Association, *Bulletin*, XXVI, 187, June 29, 1892.

In 1874 the wages of furnace workers in the Pittsburgh district ranged from \$1.50 a day for common laborers to \$2.50 for keepers and engineers. In 1878 Pittsburgh puddlers earned slightly over \$3 a day, bar rollers \$4.50 a day, heaters \$5.20 a day, and sheet rollers, who were among the best-paid men in the works, \$6.35 a day. Wages were considerably higher in the western district than in the eastern; and in 1879 the Western Nail Association complained that its members were compelled to pay their employes from one-third to one-half more than did the works of their competitors in the East.[7] Ten years later scrappers and cupola men at the Edgar Thomson Steel Works, who were paid upon a sliding scale, earned in the vicinity of \$8 for a 12-hour day. These were among the highest earnings in the establishment. In the rolling mills wages ranged from \$3.00 to \$6.00 a day for skilled hands, but there were many helpers and laborers whose pay for $8\frac{1}{2}$ hours' work was only \$1.50. The Carnegie enterprises were reported to be generous to their employes and Mr. Carnegie himself favored paying wages on a sliding scale, stipulating that the lowest rate paid in the plant to common laborers should never fall below \$1.20 a day.[8] This was in a period of temporary depression, unemployment and wage reductions.

AMERICAN IRON AND STEEL ASSOCIATION

The iron and steel industry illustrates nearly every form of organization that has appeared in the history of American manufacturing. Furnace owners and mill men are affected more by business crises than most other producers; they supply the materials and implements, the fixed capital, employed in development, to a greater extent than their industrial colleagues, and consequently they have felt seriously the sudden checks which the expansion of a country growing as rapidly as the United States has at various times experienced. Therefore, iron and steel makers have had exceptionally strong motives for combining for mutual protection, both against foreign competition and against ruinous competition among themselves. Their industry also derives notable advantages from controlling its own raw materials and is thus encouraged to seek vertical combination, that is, to unite under one control all the processes of production from the extraction of ore to the manufacture of finished products.

The American Iron and Steel Association, founded in 1864, as the successor of the defunct American Iron Association organized nine years earlier, was already a well-established institution when the panic of 1873 broke upon the country. It remained what it originally was designed to be, a society national in scope and quasi-scientific in purpose. It maintained a central bureau or clearing house for the statistics of iron and steel pro-

[7] American Iron and Steel Association, *Bulletin*, VIII, 322, Oct. 29, 1874; X, 60, Feb. 23, 1876; XII, 203, Sept. 4, 1878; XIII, 94, Apr. 16, 1879.

[8] American Iron and Steel Association, *Bulletin*, XXII, 117, Apr. 11, 1888; XXII, 297, Oct. 3 and 10, 1888.

duction, and served the function specified in its constitution, of providing for the mutual interchange of information and experience both scientific and practical relating to the industry. The Association's *Bulletin* is a repository of both trade and technical intelligence. This society at times exerted itself actively in behalf of a high tariff, especially on the commodities and articles which its members produced, but it never attempted to regulate wages or prices or to control production. Indeed, these functions would have been exceedingly difficult to perform, since this body embraced many distinct branches of manufacturing, several of which served as suppliers of raw or half-finished materials to others.[9]

ATTEMPTS TO CONTROL OUTPUT AND PRICES

Meanwhile a great number of organizations, some of them very transitory, were formed at different times to regulate output and prices. Makers of pig iron organized in 1872 as a National Association, and during the depression which accompanied the panic of the following year this new body attempted, though unsuccessfully, to bring about an agreement to curtail production. Indeed the Association subjected itself to vigorous criticism by this act. A second attempt to accomplish the same object was made in 1875, but it also was a failure.[10] In fact, pig-iron producers operated under such different conditions in the widely separated sections of the country, and they served markets so distinct, both in respect to the quality of iron consumed and the competitive conditions controlling prices, that it was almost impossible to secure an agreement among them. Local associations consequently took the place and served the purpose of the national society.

In 1874 the pig-iron manufacturers of the Lehigh Valley met to pass resolutions recommending a curtailment of output, and invited neighboring furnace owners in the Schuylkill and Susquehanna Valleys and in New Jersey to meet them for further conference. A similar convention of all the pig-iron manufacturers east of the Allegheny Mountains was held in 1883 to form "The Eastern Pig Iron Association" for "the mutual protection of the interests common to the members." The same year southern pig-iron manufacturers held a convention at Calera, Alabama, for the purpose of organizing a southern association of the same character.[11] Western furnace owners formed the same year the Western Pig Iron Association. This Association dealt with such questions as output and prices, but was also largely interested in securing, by combined action, better rates for raw materials, especially Lake Superior ore. The membership of these societies

[9] American Iron and Steel Association, *Bulletin*, VIII, 118, Apr. 9, 1874; XXXIII, 140, Aug. 15, 1899.

[10] American Iron and Steel Association, *Bulletin*, VII, 9–10, Sept. 11, 1872; VII, 204, Feb. 26, 1873; VII, 332, June 18, 1873; VII, 340, June 25, 1873; VII, 349, July 2, 1873; VIII, 384, Dec. 17, 1874; IX, 12, Jan. 22, 1875.

[11] American Iron and Steel Association, *Bulletin*, VIII, 348, Nov. 19, 1874; XVII, 12, Jan. 17, 1883; XVII, 52, Feb. 21, 1883.

was ordinarily limited to furnace men making pig iron for sale in the open market, but in 1891 the iron manufacturers in the Shenango and Mahoning Valleys formed an association, succeeding an earlier society of the same general character, which included owners of rolling mills and pipe works, as well as the proprietors of blast furnaces. The chief purpose of this association was to secure "equitable freight rates" on raw materials and finished products.[12]

One of the most interesting, and for a period the most active, of these societies was organized in 1879 by the makers of charcoal pig iron and blooms, partly to devise ways to check the decline of that branch of the industry. Anthracite and coke iron were invading fields of which charcoal iron had previously held the monopoly, and mild steel was beginning to supplant bloomery iron in many lines of manufacture. The problem of protecting timber resources in order to preserve a supply of charcoal also presented itself to this association. Its meetings, like those of the engineering societies to be mentioned later, were usually held at places that afforded an opportunity for the inspection of model mines and plants, and its proceedings contain many technical papers of value presented at its sessions. In 1887, with the growing geographical restriction of the industry, a local charcoal iron association was formed, limited to owners of Lake Superior furnaces.[13]

Bar-iron manufacturers also had an organization with a history very similar to that of the pig-iron makers. Beginning as a national association, it soon divided into a western and an eastern society, each of which met periodically, mainly for the purpose of agreeing upon prices, and when necessary upon limitation of output. In 1879 a convention of eastern mill owners reported that no good reason could be assigned for the recent irregular and ruinously low prices for certain products manufactured by its members "except want of confidence and ignorance of one another's actions," and appointed a committee to revise the Association's price schedule and to confer with mill owners in other parts of the United States regarding its enforcement. Ten years later the convention had a firmer control of its market and deemed it inexpedient to change prices, "the general seaboard rate being two cents a pound."[14] In 1877, the Western Association resolved that mills belonging to that body "hereby agree to limit themselves to running single turn or its equivalent."[15]

Bessemer steel works represented a more formal community of interests since they were joint owners and sole possessors of indispensable patent rights, but the crucible steel works of the country organized in 1879, on

[12] American Iron and Steel Association, *Bulletin*, xvii, 19, Jan. 24, 1883; xvii, 85, Mar. 28, 1883; xxv, 37, Feb. 11, 1891.

[13] American Iron and Steel Association, *Bulletin*, xiii, 181, July 16, 1879; xiii, 236, Sept. 17, 1879; xvii, 189, July 11, 1883; xix, 293, Nov. 4, 1885; xxi, 293, Oct. 19, 1887; xxi, 309, Nov. 2 and 9, 1887.

[14] American Iron and Steel Association, *Bulletin*, vii, 437, Sept. 17, 1873; xiii, 36, Feb. 26, 1879; xxiii, 356, Dec. 25, 1889; xxiv, 285, Oct. 1 and 8, 1890.

[15] American Iron and Steel Association, *Bulletin*, xii, 25, Jan. 23 and 30, 1878.

the same basis as pig-iron and bar makers, to promote their mutual interests. Seven years later the "Steel Manufacturers' Association of the United States" was formed by makers of merchant steel. This society embraced practically every establishment engaged in that line of production in the country, and determined the classification of steel products and at least nominally standardized prices.[16] Reproductive manufacturers of iron and steel organized for similar purposes. Among the summer trade announcements for 1873 were meetings of the National Association of Stove Manufacturers and the Western Rail Mill Association.[17] Western nail makers' and tin plate associations were notable examples of these societies. They differed from pools mainly in the fact that they did not pro-rate business to their members.

VERTICAL INTEGRATION

Another phase of organization remains to be considered, although it had only a beginning in the larger sense during the period we are now describing. In 1872 a writer in the *Bulletin* of the Iron and Steel Association, deploring the embarrassment under which furnace owners labored during that period of extraordinary demand for their products, on account of the uncertainty and unreliability of ore deliveries and the "fluctuations and eccentricities of the market," observed:

> "The time will come when there will be less separation of these interests. The pressure of this season has developed strong efforts toward their combination. Every day almost, furnace and mill owners are looking over Lake Superior mines to obtain, if possible, such an interest in their working as will guarantee them a regular supply of ore of uniform quality. The inevitable is approaching very rapidly."[18]

At an earlier period many iron companies mined their own ore and coal, smelted their own pigs and converted the latter into rails and other finished products. But with the expansion and growing differentiation of plants and the employment of ore and fuel from distant sources, this unity of control over all the processes of production was becoming the exception.

During the depression following the crisis of 1873 conditions did not encourage the vertical combination which the writer just quoted suggests. Capital was hard to get. The market was oversupplied with raw materials. Many a furnace owner could buy his coal or ore for less than it would have cost him to mine them on his own property and transport them to his furnace. None the less, the tendency here predicted was sure to reassert itself as soon as the demand for iron and steel products again became active. In 1886, the North Chicago Rolling Mill Company purchased 1,000 acres of the most valuable land containing coking coal in the Connellsville region,

[16] American Iron and Steel Association, *Bulletin*, XIII, 228, Sept. 10, 1879; XX, 11, Jan. 13, 1886; XXI, 309, Nov. 2 and 9, 1887.
[17] American Iron and Steel Association, *Bulletin*, VII, 332, June 18, 1873.
[18] American Iron and Steel Association, *Bulletin*, VII, 9, Sept. 11, 1872.

although it did not immediately put up ovens. Most of the Bessemer steel works smelted their own iron and several of these companies mined their own ore and coal.[19]

HORIZONTAL COMBINATIONS

A union of companies in the same or kindred branches of the industry was not uncommon. In 1875 the Albany and Rensselaer Iron and Steel Company was formed to take over the businesses of John A. Griswold and Company and of the Albany Iron Works lately owned by Erastus Corning and Company, thus bringing under the same control the principal iron and steel establishments of this iron-working center.[20] Combination of works situated in different places also occurred, such as the union under single ownership and management of the furnaces and rolling mills at Milwaukee and at North and South Chicago. In 1881 the Standard Coal and Iron Company attempted to consolidate nearly all the coal and iron interests of the Hocking Valley.[21] The tendency toward concentration was so observable before the middle eighties that the relative economy of large and small establishments was often discussed in trade journals and at manufacturers' conventions.[22] During the era of great amalgamations about the end of the century, when trust legislation and trust litigation were occupying the attention of the country, it was pointed out that while most such corporations had been organized since 1895, "there had previously existed a sufficient number of these enterprises to justify the prediction, if anybody had thought of making it, that there would be more to follow." Instead of marking a revolution in the iron trade, the development at the latter date was but the high-water mark of an evolution that had begun many years previous. The Tennessee Coal, Iron, and Railroad Company, which we have already described, was organized before 1881, and during the following ten years increased its properties from 3 coke furnaces and some mining properties of moderate value, to 20 blast furnaces and numerous coal mines, iron mines and coke ovens. The Illinois Steel Company was organized in 1889 to absorb the rolling mills and steel works at Chicago, Milwaukee and Joliet, several of which companies represented previous combinations. The Carnegie interests embraced the Edgar Thomson Steel Works and blast furnaces, the Dusquesne Steel Works, the Homestead Steel Works and several other enterprises. In 1891 the Lackawanna Iron and Steel Works and the Scranton Steel Company combined.

LEADING PIG-IRON PRODUCERS

In 1888 three of the leading furnace companies of Alabama entered into an agreement to sell their product through a single commissioner.[23] This

[19] American Iron and Steel Association, *Bulletin*, XIII, 4, Jan. 8, 1879; XX, 5, Jan. 6, 1886.
[20] American Iron and Steel Association, *Bulletin*, IX, 61, Mar. 5, 1875.
[21] American Iron and Steel Association, *Bulletin*, XV, 229, Sept. 7 and 14, 1881.
[22] *E.g.* American Iron and Steel Association, *Bulletin*, XIX, 69, Mar. 11, 1885.
[23] American Iron and Steel Association, *Bulletin*, XXII, 173, May 30, 1888.

was a device for maintaining prices and preventing competition, but there was no consolidation of the companies. By 1890, however, the concentration of pig production in the country as a whole had made notable progress. The Illinois Steel Company, operating 14 furnaces with a capacity of about 800,000 tons per annum, had the maximum output. The Carnegie interests at Pittsburgh, which controlled 9 furnaces with an aggregate capacity of 600,000 tons, were the next largest producers. This group had two furnaces under construction which promised to raise its annual output to about that of the Illinois Company. At this date the Tennessee Coal, Iron, and Railroad Company ranked third in production, with 10 furnaces having a capacity of about 400,000 tons per annum; but the Pennsylvania Steel Company with 4 stacks in operation and 4 under construction promised soon to wrest that position from its southern rival. The Cambria Iron Company with 9 furnaces in Pennsylvania produced about 350,000 tons of pig iron per annum. Among the eastern furnace groups, the Thomas Iron Company was the largest maker of foundry pig iron for the open market. It controlled 12 furnaces of moderate size in eastern Pennsylvania with an aggregate output of about 200,000 tons a year.[24]

[24] American Iron and Steel Association, *Bulletin*, XXIII, 148, June 5, 1889.

CHAPTER XXV

COSTS, PRICES AND TRADE CONDITIONS

PIG-IRON PRODUCTION COSTS

Naturally costs of production of iron and steel are never uniform throughout a country having the area and presenting the varied conditions of the United States. During these twenty years the average cost of making pig iron declined, although it may have risen in particular localities. If costs rose or remained stationary anywhere it was probably at the charcoal furnaces in the East. A comparison of those at the same furnace in the Lehigh Valley in 1857 and 1892 showed a decline in every item. Coal, ore, limestone, labor and presumably supplies and interest were less at the latter date than at the former. The ore was taken from the same mines; the furnace was blown by the same power; the fuel was anthracite coal received at both dates from the same source; but in 1857 the furnace books indicated that it cost a trifle over $19.50 to produce a ton of iron; in 1892 this figure had fallen to between $11 and $12.50 a ton, according to the grade of iron produced. This reduction was attributed to a better selection of ores and to scientific furnace management.[1]

In a discussion of furnace costs in 1899, Captain Robert W. Hunt, of Chicago, summed up the principal changes of the previous quarter of a century as follows:

> "When Sir Lothian Bell in 1874 gave strong reasons why it would never be possible for iron to be made more cheaply in the United States than in England, his arguments were based on geographical and physical obstacles which then appeared to be unsurmountable. The geographical obstacles remain unchanged, but some of the physical have been greatly altered. The ore beds are no nearer the sea; the coal is as far away from the furnaces; American labor still receives higher pay; but the cost of mining and transporting ore has been reduced; coal and coke prices have been made less to the consumer; and labor produces more per day per man."[2]

This question of furnace costs was more or less controversial. Iron makers occasionally reported them at what was probably an unduly high figure, especially in discussions having to do with the tariff, while their

[1] American Iron and Steel Association, *Bulletin*, xxvi, 155, June 1, 1892; *cf. id.*, xviii, 53, Feb. 20 and 27, 1884.

[2] Quoted from London *Engineering*, in American Iron and Steel Association, *Bulletin*, xxxiii, 218, Dec. 20, 1899.

free-trade opponents sometimes made them unfairly low. Then again men interested in promoting furnace construction in new districts, especially the South, were wont to take too optimistic a view of the price at which iron could be made in the locality in which they were interested. These two causes of bias did much to confuse the figures of the period. Moreover, costs fluctuated violently in response to varying factors which might change almost overnight. For instance, the water freight on Lake Superior ores sometimes doubled between seasons. In 1888 the Lehigh Valley furnace owners secured reductions on coal and ore freight from the Lehigh Valley Railroad that lowered their cost of making pig iron over a dollar per ton.[3] Since this concession was accompanied by a decrease in wages, the drop was both sudden and material.

It was estimated in the late eighties upon a basis of selling prices in northern markets, that it cost from $11 to $12 a ton to produce pig iron at the Alabama furnaces.[4] Naturally, conditions varied from establishment to establishment. For instance, the quantity of bituminous coal and coke required to make a ton of iron ranged in the middle eighties from 1.30 tons in Illinois to 2.13 tons in Kentucky; and the quantity of ore required to make a ton of iron ranged from 1.45 tons in Illinois to 2.60 tons in Maryland.[5]

Cost of production naturally had a bearing upon prices, but inadequate as our data are, they nevertheless indicate that seasonal prices and cost of production did not necessarily move in parallel curves, although in the long run they naturally kept company. There were three periods of particularly low prices, or of abrupt price declines, for iron and steel between the panic periods of 1873 and 1893. The first followed immediately on the heels of the former panic; the second occurred about midway between the two depressions, in 1884 and 1885; and the third immediately preceded the crisis of 1893. The lowest point in the first of these three periods was reached in 1878, when number-one foundry iron fell to $16.50 a ton at Philadelphia, and gray forge iron from Lake Superior ore to $16 a ton at Pittsburgh. These were recorded as the lowest prices since colonial days. During the depression in the middle eighties, gray forge iron declined to $14 at Pittsburgh, but foundry iron did not fall below $17.50 at Philadelphia. By the fall of 1893, however, new low records were made, anthracite foundry iron falling to $13.75 at Philadelphia and gray forge iron to $10.25 at Pittsburgh. Decreased costs of production, of course, influenced the minimum to which prices could descend.[6]

General market conditions not only influenced production costs by their direct effect upon wages, transportation charges and the price of purchased supplies and raw materials, but they also varied the margin between the

[3] American Iron and Steel Association, *Bulletin*, XXII, 149, May 9, 1888.
[4] American Iron and Steel Association, *Bulletin*, XXIII, 180, July 3, 1889.
[5] American Iron and Steel Association, *Bulletin*, XIX, 124, May 13, 1885.
[6] American Iron and Steel Association, *Bulletin*, XVIII, 5, Jan. 1, 1894; *Commercial and Financial Chronicle*, LXIV, 1163, June 19, 1897.

producing and the selling price. Steel rails fell as rapidly as pig iron during these twenty years, in response to radical improvements in labor-saving machinery and manufacturing processes. The lowest point they reached in the seventies was $40, from which they declined to $26 in the middle eighties, and to $22 soon after the crisis of 1893. At no time during this period did American prices fall as low as those in Great Britain, where Cleveland pig iron was sold F. O. B. in 1888 at $7.97 a ton, or less than half the price in Philadelphia the same year.[7]

TRADE DEPRESSION OF THE SEVENTIES

The effects of the panic of 1873 continued to be felt by the iron and steel industry until 1879, though with varying degrees of intensity and short periods of partial recovery. In 1873 railway construction fell off nearly one half from the average of the years immediately preceding. Railway managers faced by declining business and the other uncertainties of a period of deflation and falling prices, bought only such equipment and made such repairs as were vitally essential in order to continue operations. It was estimated that the railways consumed approximately half of the iron and steel produced in the United States; and if their consumption declined one half, the decrease in the demand for iron and steel products was evidently so large as completely to upset market conditions and to cause heavy over production. For furnaces did not blow out, as a rule, as long as they had orders ahead or raw materials in stock which they could convert into metal and metal products and thus keep their hands employed.

This explains what we have noted elsewhere, that the total output of our furnaces in 1875 was a few thousand tons in excess of the quantity produced in the boom year of 1872. By the end of the season, however, furnaces were rapidly going out of blast and during the following year nearly half of those in the country were idle. Iron was accumulating and its presence in the market at a time of declining demand discouraged resumption even though some of the idle furnaces might have made iron at a profit at the prices temporarily prevailing. The period of most acute depression was 1874, although even that year had its brief period of hopefulness, especially during the opening months when optimists imagined that signs of improvement were visible upon the horizon. In September the Rensselaer Iron Works at Troy, which had been idle for five months, resumed making steel, and other branches of the iron industry in the Hudson Valley began to pick up; but such evidences of returning prosperity were strictly local and seasonal, and no indications of a general and permanent improvement appeared during this year.[8] Late in February 1875, half of the furnaces in the Lehigh Valley region were idle and had been so

[7] American Iron and Steel Association, *Bulletin*, XXIX, 133, June 10, 1895; *Commercial and Financial Chronicle*, LXIV, 1163, June 19, 1897.

[8] American Iron and Steel Association, *Bulletin*, VIII, 172, June 4, 1874; IX, 4, Jan. 8 and 15, 1875.

for months. Furnace owners who had but half of their stacks in blast would have been able to make iron for a dollar less per ton, according to their estimates, if their works had been in full operation. Naturally, they were anxious to resume at the earliest moment possible, especially as their idle workmen, many of whom had homes in the vicinity, were clamoring for employment; yet the production in the Lehigh Valley was less than at any time since 1853.[9]

Late in 1875 the surplus stocks of pig iron had begun to disappear. Little was reported in the warehouses and furnace yards of Pittsburgh and the regions farther west. In fact by autumn of this year distinct evidences of revival had begun to manifest themselves in that section. Even as early as July the western iron trade was reported to show "every indication of health and activity." Profits were small, but the stagnation of the previous season had disappeared. Nearly every rolling mill at Pittsburgh was running and selling its product. All the large steel works in the same city were busy. The western demand for "agricultural steel" was reported greater than ever before.[10] At the end of the year the production of pig iron proved to have been unprecedently large "considering the limited demand." By this time wages, freights and the price of raw materials had declined to a point that enabled furnace owners to produce at materially lower prices than hitherto. Among the older firms which disappeared during this period of depression was the Brady's Bend Iron Works, which twenty years before had been one of the largest establishments in the country.[11]

Psychological conditions were more favorable for a business revival in 1876, the Centennial Year, than they had been since the panic. Liquidation, reorganization and economies enabled manufacturers to produce at lower costs and inspired them with greater confidence in their ability to survive a period of low prices and narrow profits. The Centennial itself, recording as it did all the marvelous progress of the nation in wealth and population during the previous century, was a lesson in optimism. As early as April prices of metal products in the west were visibly stiffening, and although there was a short stagnant season in midsummer, it was not accompanied by a break in quotations, and the autumn revival gave a decidedly better tone to the market.

It should be observed in this connection that the iron trade of Great Britain also had "never been in so deplorable a condition." In America the first signs of improvement appeared in the general market. The hardware trade was active; dry goods were selling more freely; exports were increasing. As yet, however, locomotive works, rolling mills and kindred industries showed little sign of improvement. One effect of the depression

[9] American and Steel Association, *Bulletin,* IX, 42, Feb. 19, 1875; IX, 52, Feb. 26, 1875; IX, 214, July 16, 1875.

[10] American Iron and Steel Association, *Bulletin,* IX, 196, July 2, 1875.

[11] American Iron and Steel Association, *Bulletin,* VIII, 61, Feb. 19, 1874; X, 13, Jan. 12, 1876.

was to make the iron and steel industries more dependent than hitherto upon general consumers for their market.[12] By this time the long continuance of unemployment or partial and scantily remunerative employment in the iron region stimulated the migration of workmen to the unsettled districts of the western states, where the sales of Government land more than doubled between 1877 and 1878, increasing from less than 3,500,000 acres to over 7,500,000 acres. Naturally, this depression rested heaviest upon the districts where iron making was declining or struggling against adverse natural conditions. In 1877 not a furnace was in blast in the state of Missouri and the iron works of St. Louis were idle. The summer of this year was characterized by a peculiarly torpid market for pig iron, and the situation was not improved by a great railway strike and the ensuing freight embargo. One noticeable feature of this period was the large number of plants lost by fire. A single issue of the *Bulletin* of the American Iron and Steel Association in 1877 records the destruction of five plants in this manner.[13]

Among the earliest indications of real revival was an increased demand for railway equipment. Orders for locomotives and rails came in during 1878 more freely than for several years past. In 1877 the country had been blessed with magnificent crops; exports had increased; the tariff question and the silver question were at least momentarily settled and railway earnings were increasing. Pig-iron prices were kept down in some localities by the placing of storage iron upon the market, some of the offerings having been held over since the failures of 1873; and charcoal iron continued dull, partly because during the stress of the crisis, when every effort was made to cheapen manufactures to meet the conditions of the stagnant market, coal and coke irons had been substituted for it.

By the autumn of 1878 omens of better times were multiplying. The building of the New York Elevated Railway created a new demand for structural iron, large enough in itself to give a tone of optimism to the market. Furthermore foreign purchasers were looking to America for iron manufactures during this period of unprecedentedly low prices. Machinery for New South Wales and iron vessels for foreign governments were under construction at Philadelphia and along the Delaware. Indeed, the shipbuilding business received a decided stimulus from the temporary cheapness of the materials which it used. All over the country an increased demand for pig iron was observable. By late autumn reports of furnaces blowing in after a long period of quiescence were numerous; and the Edgar Thomson Steel Works and the Cambria Company were planning to build new furnaces. Prices continued abnormally low, especially in the East, where many iron makers were probably running at no profit and often at an actual loss. While the companies owning the best mines and operating

[12] American Iron and Steel Association, *Bulletin*, x, 177, June 28, 1876; x, 253, Sept. 20, 1876.
[13] American Iron and Steel Association, *Bulletin*, xi, 157, June 6, 1877; xii, 21, Jan. 23 and 30, 1878.

the most improved furnaces might make a small profit, the law of the survival of the fittest was being enforced in this section with the utmost rigor. Around Pittsburgh conditions were better and prices firmer, but the depression in the Shenango and Mahoning Valleys continued.

The elimination of small and uneconomical plants and a sharp rise in the number of failures among iron makers and secondary manufacturers of iron were not the only evidences of the stress brought upon the industry as a whole by this long period of curtailed production and unremunerative operation. The tendency to concentrate the trade in the hands of large corporations was growing stronger. The Bethlehem, Harrisburg and Cambria works, which had owned blast furnaces ever since their steel plants were started, were making additional efforts to control their sources of raw materials and to diversify their products, especially to produce shapes and articles for consumption outside the railway field. Consequently the capacity of these establishments was being steadily increased. A writer of the period observed:

"The dying out of old furnaces, the building of new furnaces, the alternate stagnation and activity of the wrought-iron business, the constant and increasing activity of every branch of the steel trade, the substitution of iron for wood, and of steel for iron, the multitude of new types of iron and steel furnaces and of new processes all struggling for existence at once, furnish a problem for the ironmaster the like of which has not been seen in this generation."[14]

THE BOOM OF 1879–1880

Notwithstanding evidences of better times, failures among iron and steel makers continued numerous during the first half of 1879, and culminated in the foreclosure of a mortgage against the Joliet Iron and Steel Works in May of that year.[15] When the revival began, however, it developed with remarkable rapidity. By the end of March the leading establishments in the country were working full time and increasing their capacity. Within a year and a half the stock of the Bethlehem Iron Company advanced from less than $15 to $45 a share.[16] The price of pig iron did not return to the figures even of 1876, though by the middle of 1879 it was higher than during the intervening years, but as we have noted costs of production had been reduced during the interval. Although the demand for structural iron during these six months was without precedent, prices advanced but slowly. A suggestive indication of the improvement in the market was the heavy sales of English iron in the latter part of the summer, partly because American furnaces could not fill their orders. At that time producers in some districts were sold out until the end of the year. Even in the South, which

[14] American Iron and Steel Association, *Bulletin*, XII, 246, Oct. 23, 1878; XII, 269, Nov. 13, 1878; XIII, 6, Jan. 8, 1879.

[15] American Iron and Steel Association, *Bulletin*, XIII, 117, May 7 and 14, 1879; *cf.* XII, 44, Feb. 20 and 27, 1878; National Association of Wool Manufacturers, *Bulletin*, XII, 176–177, June 1882.

[16] American Iron and Steel Association, *Bulletin*, XIII, 150, June 11, 1879.

was supposed to be making iron at an especially low figure, some large consumers were ordering bars from England and pig from Scotland. Iron rails, which had been long neglected, were again sought by railway managers because steel makers could not take orders for early delivery. We imported large quantities of old iron rails this season to be re-rolled or to supply the place of pig. In the closing months of 1879 there was "a veritable iron famine—greater than that of 1871." Excitement and speculation ensued, and it was some months before the market returned to a healthy condition. Our imports of iron ore almost trebled this year, rising to over 284,000 tons. Some idea of the speculative possibilities of such a market may be obtained from the following figures: Anthracite foundry pig iron rose from $16.50 a ton in November 1878 to $43 in February 1880, while charcoal iron rose from $28 to $63 a ton, and steel rails rose from $40 to $85 a ton. Naturally this indicated a closed market. The agent for a southwestern railroad applied to every rolling mill in the east for 5,000 tons of rails without receiving a bid. In fact, during the depression railroads had not made their ordinary replacements and were faced by suddenly rising prices just when it became essential for them to buy extensively.[17]

Of course the market for our iron and steel was limited to the United States and that fact defined rigidly the possibility of trade expansion. Plants that had been idle for four or five years resumed production. So insistent was the demand for iron that rail mills with heavy orders in advance were obliged to shut down for long periods because they were unable to secure the needed raw materials. In spite of heavy importations and the activity of domestic producers, the demand for pig, rails and ore could not be met, and many orders, the delivery of which was urgently demanded in 1879, were carried over into 1880. Railway construction nearly doubled. On the other hand the building of iron ships did not increase, owing to the high prices of materials. A new market absorbing 20,000 tons of steel yearly was created by the manufacture of barbed-wire fencing.[18]

The revival of 1879 was followed by a period of activity continuing throughout the following year; but there were some unhealthy features in the market situation. During the long period of declining prices and moderate demand which followed the panic of 1873, the iron trade settled down to what was considered a more or less permanent price level, much lower than had hitherto prevailed. Pig iron was quoted in the vicinity of $20 a ton. So confident were furnace owners that these prices were destined to endure, that they accepted large contracts for future delivery on this basis. Some of these contracts ran for more than a year ahead. The Lake Superior ore companies sold their season's output on a basis of about $7 a ton at Cleveland. Steel companies contracted to deliver rails at $40 and

[17] *Commercial and Financial Chronicle*, XXX, 649–650, June 19, 1880; American Iron and Steel Association, *Bulletin*, XIII, 222, Sept. 3, 1879; XXXI, 204, Sept. 10, 1897; National Association of Wool Manufacturers, *Bulletin*, XII, 182–184, footnote.

[18] American Iron and Steel Association, *Bulletin*, XIV, 4, Jan. 7, 1880.

$42 a ton. In fact, the disposition to assume that the iron trade and allied branches of production had reached a firm and permanent cost level was almost universal. Suddenly, however, an unprecedented demand for iron and steel and their manufactures manifested itself. Mine owners, furnace owners and mill owners, whose product was sold for a long time ahead, found themselves producing under conditions that they had not anticipated when their contracts were made. Their luckier rivals who were in a position to take advantage of the strengthening market were making fortunes while their own costs of production rose in sympathy with the larger profits of their neighbors. This discouraged the making of new contracts, and resulted in a policy which increased the eagerness of buyers and encouraged speculation. Lake Superior ore companies immediately advanced prices for 1881 from a $7 to about a $12.50 basis at Cleveland. This situation, and especially of the speculative character of the market, eventually discouraged buyers and toward the close of 1880 caused a recession of prices.[19]

The depression of the previous years and the abnormal stimulus of the market in 1879 and 1880 were not confined to America. Their effect was felt in Europe and Great Britain, where the anticipation of a prolonged era of high prices encouraged a marked increase in furnaces, steel works and rolling mills. The same result naturally occurred in the United States, where productive capacity tended to grow faster than the requirements of consumers. Consequently demand for most iron and steel products sensibly slackened during the winter of 1881 and 1882.

The period of speculative dealing we have just described precipitated several failures among iron traders, especially the importers of New York and Boston.[20] In the summer of 1880 the Midvale Steel Works, one of the largest establishments in the country producing crucible and open-hearth steel, were sold under mortgage foreclosure;[21] and this was but the first of several insolvencies in that branch of the industry. In January 1882, the Siemens Anderson Steel Company of Pittsburgh failed, and the following year the Union Iron and Steel Company of Chicago and the Standard Coal and Iron Company, of Ohio, which had attempted to bring under a single management all the important iron and coal companies of the Hocking Valley, went into the hands of receivers.[22]

DULLNESS OF THE EARLY EIGHTIES

The depression which followed the prosperity of 1879 and 1880 affected principally producers of pig iron. Other branches of the iron and steel

[19] American Iron and Steel Association, *Bulletin*, XIV, 90, Apr. 14, 1880. A marked fall also occurred in the spring of 1880: American Iron and Steel Association, *Bulletin*, XV, 14, Jan. 12, 1881; XXXI, 204, Sept. 10, 1897.

[20] American Iron and Steel Association, *Bulletin*, XIV, 3, Jan. 7, 1880; XIV, 139, June 9, 1880; XIV, 146, June 16, 1880.

[21] American Iron and Steel Association, *Bulletin*, XIV, 154, June 23 and 30, 1880; XIV, 212, Sept. 1, 1880.

[22] American Iron and Steel Association, *Bulletin*, XVI, 12, Jan. 11, 1882; XVII, 37, Feb. 1, 1882; XVII, 33, Feb. 7, 1883; XVII, 51, Feb. 21, 1883; XVII, 349, Dec. 19 and 26, 1883.

industry continued to be reasonably prosperous at a time when furnace owners were beginning to feel the effects of the coming stagnation. The peculiar difficulties of the latter were accounted for mainly by three causes: Foreign importations which, though not exceeding 150,000 tons a year, tended to hold pig prices down to a certain maximum; the high price of anthracite coal in the East, which was one of the causes for its rapid abandonment as a blast-furnace fuel; and the abnormally high prices of Lake Superior ores in the West. The most favorable aspect of the situation for furnace owners was the fact that stocks were not accumulating.[23]

Abnormally poor harvests in 1881, particularly throughout the West, reacted directly upon the prosperity of the railroads, and through them on the iron and steel industry. The price of Bessemer rails fell from $60 to $50 during the first five months of 1882, dragging down the price of pig iron also. For the first time since 1876 the balance of trade turned against the United States, and there was consequently less buoyancy than usual in the money market. In the summer of 1882 the iron workers of the Pittsburgh region went on strike, thus adding to the difficulties of manufacturers in that vicinity.[24] Behind the whole situation, however, lay the fact that the capacity of American furnaces and steel works was increasing faster than the country's ability to consume their products. An English manufacturer, who visited the United States periodically, declared in 1882 that western works were fully five years ahead of the demand, citing in detail the increases in the capacity of the plants between Cleveland and Pittsburgh.[25] This prediction proved wrong in the event, but it draws attention to the irregular rhythm that characterized the growth of the industry. During 1881 the most favorably situated furnaces and iron works ran to full capacity; but the following year there was more or less interruption in most establishments; and when the Pittsburgh strike closed the rolling mills of the west for about four months the cessation of production was not altogether unwelcome to their owners. Toward the close of the year Bessemer steel works began to curtail output. Prices of pig iron remained remarkably uniform, though a slight decline, to about $20 a ton, occurred at the end of the season. Meanwhile the price of steel rails fell precipitately from $58 in January to $38.50 the following autumn, by which time rail mills were shutting down in rapid succession. On December first the North Side Mills at Chicago, the Joliet Mills, and the Philadelphia and Reading Company's mills ceased operations.[26] The falling off in railway demand was not limited to rails, for the poor harvest of the previous year had caused railway managers to reduce orders for equipment to a minimum. Not only was there less grain to ship than ordinarily, because

[23] American Iron and Steel Association, *Bulletin*, xv, 148, June 15, 1881; xv, 267, Oct. 19 and 26, 1881.
[24] American Iron and Steel Association, *Bulletin*, xvi, 300, Nov. 8, 1882.
[25] American Iron and Steel Association, *Bulletin*, xvi, 155, June 7, 1882.
[26] American Iron and Steel Association, *Bulletin*, xvi, 324, Dec. 6, 1882; xvii, 6, Jan. 3 and 10, 1883.

local harvests were poor and because European harvests were good, but farmers curtailed purchases of agricultural implements and other farm equipment, so that the season was likewise a bad one for machinery makers in the West, who normally were large buyers from the local steel works.[27]

The price decline so characteristic of the decade continued ruthlessly to eliminate less fit producers, or at least to silence their machinery for the time being. By the summer of 1884 rails were sold by the Edgar Thomson Company at a price netting $28.50 a ton at the works. This branch of the industry was suffering more from overproduction and the general depression than any other line of steel manufacturing. That summer the St. Louis Ore and Steel Company, operating one of the largest establishments of its kind in the West, went into the hands of a receiver, after distributing its rail contracts to other firms able to make rails at a profit for less than the cost of manufacturing them in St. Louis. In September of this year the Western Pig Iron Association made an effort to secure a general curtailment of output which was partially successful. Of the 47 furnaces in the Shenango and Mahoning Valleys with an aggregate annual capacity approaching 900,000 tons, only 10, representing one-fourth of this capacity, were in blast; and of the 26 rolling mills in the same district, 11 were idle and the remainder were running irregularly.[28]

Meanwhile owners were again making contracts for future delivery as much as nine months in advance, at figures reported to be below the cost of production at the time the contracts were signed. These conditions led to constant efforts to decrease those costs and in many instances to reduce wages to a point which even some employers considered unwisely low. At the close of the year the Edgar Thomson Steel Works, which were equipped to make steel at as low cost probably as any establishment in the country, shut down indefinitely. When the season closed good mill iron was selling at Philadelphia at $16 a ton, and the average price throughout the year was $18.50. On the other hand manufacturers of steam engines, iron and wood making machinery, steam pumps, hardware, and barbed wire were well employed, and the low price of raw materials and partially manufactured steel was evidently giving encouragement to secondary industries. This year witnessed several serious failures, the most important being that of Oliver Brothers and Phillips, and the Oliver and Roberts Wire Company of Pittsburgh, a group operating several large mills in that vicinity.[29]

A NEW CYCLE OF ACTIVITY

Nevertheless premonitions of the period of prosperity that was to last, with minor recessions, until the crisis of 1893, were already in the air. Large contracts for structural iron, to extend the elevated railways of

[27] American Iron and Steel Association, *Bulletin*, XVI, 300, Nov. 8, 1882.

[28] American Iron and Steel Association, *Bulletin*, XVIII, 188, July 23, 1884; XVIII, 233, 237, Sept. 17, 1884.

[29] American Iron and Steel Association, *Bulletin*, XVIII, 179, July 16, 1884; XVIII, 258, Oct. 8, 1884; XVIII, 331, Dec. 24 and 31, 1884; XIX, 4, Jan. 7, 1885; XIX, 20, Jan. 21, 1885.

Brooklyn, and for steel rails, were closed in the autumn of 1884. Late in the season some large purchases of foundry iron were made in the South. The following winter eight of the nine furnaces in the Birmingham district were in full blast. In Tennessee but a single stack was idle and not a charcoal furnace had blown out. Freights were low and Southern irons were moving freely toward Northern markets. This, to be sure, was unsatisfactory for furnace owners in the North and East, especially in the anthracite district, although even there the tone of the market was more encouraging and there was a steady increase of production during the first quarter of the year.[30] By spring barbed-wire mills, stove foundries, boiler works and other establishments engaged in the secondary manufacture of iron and steel at St. Louis were reported to be in full operation. Steel rails advanced somewhat in the spring and their price took a more decided turn upward later in the season, with the result that pig-iron quotations rose in sympathy. The better tone of the rail market was due in part to an agreement among producers to limit and pro-rate the output for the year, which was fixed at 775,000 tons. No restriction was placed on prices, with the result that the latter rose from $26 or under in April to $35 in December, at which time manufacturers enlarged the limit of production for the year to one million tons. In taking this action American rail makers were following the example of their European colleagues, who had maintained a similar combination for the past two years.[31]

The statement that the advance in rail prices was due to the action of manufacturers in restricting output must be qualified by the consideration that the prices of other iron and steel products rose simultaneously, in response to a demand that became visibly active from the beginning of the autumn. In fact, some branches of the industry had been improving for a longer period. This was particularly true of nail making, and several nail factories added steel converters to their works. A Bessemer plant was erected at Mingo Junction to supply the nail mills of the upper Ohio district, and other plants were projected in the same vicinity. Several new steel works or additions to existing works were also erected in the East. In that section stress was laid mainly at this time upon improving the quality of product instead of upon reducing cost of production. This was partly due to the fact that the lower wages paid to puddlers and rolling-mill employes in the East made it possible to work iron more cheaply in that section than to manufacture steel. In the West conditions were the reverse and steel could be produced more cheaply than wrought iron. This condition tended to confine the employment of steel in the East to uses where special qualities were required.[32]

Pig-iron prices were the last to recover and did not respond proportionally to the growth of consumption. The tendency for the output of iron smelted

[30] American Iron and Steel Association, *Bulletin*, XVIII, 228, Sept. 3 and 10, 1884; XVIII, 261, Oct. 8, 1884; XIX, 38, Feb. 4 and 11, 1885; XIX, 51, Feb. 25, 1885.

[31] American Iron and Steel Association, *Bulletin*, XIX, 77, Mar. 18 and 25, 1885.

[32] American Iron and Steel Association, *Bulletin*, XIX, 148, June 10, 1885; *cf. id.*, XVIII, 21, Jan. 16, 1884.

with coke and bituminous coal to increase at the expense of iron smelted with anthracite fuel and with charcoal was very marked, partly because the manufacture of iron was increasing in many sections of the country previously undeveloped, and particularly in the South where only bituminous coal was produced. Yet the output of New York furnaces, where iron had always been smelted with anthracite, was growing. A review of prices for 1885 stated that the highest figure ever touched by pig iron was in August 1864, when it was $73.63 a ton—it had three years previously been down to below $19; and the highest price in the period between 1870 and 1885 was $53.87, in September 1872. The lowest price ever reached up to 1885 was $16.50 in November 1878, from which there was a rise to $30.50 in December 1879, and to $41 two months after, in February 1880. In the latter part of 1884 the price had fallen to $18.50 again, and in 1885 it ruled for a time at $17.75 from which there was a rise to $18.25 at the close of the year.[33]

During 1886 the market remained steady at a fairly high level and iron and steel manufacturers were prosperous. Prices of iron and steel were kept within reasonable limits, although there was a rapid increase in demand, especially from the railways. The absence of anything resembling a boom in spite of the generally optimistic character of the market was partly due to labor disturbances. Early in the year a strike occurred in the Connellsville coke district followed by the great Missouri Pacific Railroad strike and anarchist outbreaks at Chicago. Though the relations between employes and employers in the iron trade were in the main harmonious, these conditions reacted upon business sentiment.[34]

Another of the incessant alterations in market conditions occurred in 1887. By the middle of the summer a decline in prices set in, partly because the enlargement of old plants and the construction of new ones during the recent period of prosperity had increased output beyond the immediate needs of the country. The railroads were somewhat intimidated by the creation of the Interstate Commerce Commission. Moreover, heavy importations of iron and steel had occurred, sufficient to depress prices and to weaken home demand. These depressing influences were partly counteracted by the fact that more railroad mileage was under construction than the previous year; and locomotive works and car shops had more orders than they could fill. Crops were good and the general business condition of the country was sound. In 1885 only 3,600 miles of new road had been built; in 1886 these figures rose to 9,000 miles; and in 1887, to over 14,000 miles; but the curtailment that was to reduce these figures to 7,000 miles of new construction the following year was already foreseen. Money for building new roads was not as abundant as previously. A drought in the West, and the Baltimore and Ohio receivership, undermined confidence. Although

[33] *Commercial and Financial Chronicle*, XLII, 140–142, Jan. 30, 1886.
[34] American Iron and Steel Association, *Bulletin*, XX, 348, Dec. 29, 1886.

the price of pig iron had been falling slowly for several months, the cost of ore, fuel, freight and labor remained unchanged, and the anticipation of readjustments of the latter also created uneasiness in the industry. During the summer months another strike occurred in the Connellsville coke district, which resulted in the banking of some furnaces; but this did not affect the South, which used local fuel and Virginia coke.[35]

Declining prices for pig iron and increasing competition between furnace districts characterized the first months of 1888. In March representatives of the blast furnaces and other iron works of the Lehigh Valley, at a meeting held at Easton, Pennsylvania, resolved unanimously that Eastern makers could no longer compete with Southern and Western furnaces at the existing rates of freight. For some time past the furnaces of western Pennsylvania had been crowding eastward for new markets, while those of the Mahoning Valley were paying increased attention to customers in northern New York and New England. Late in March, and again in May, the price of gray forge pigs delivered at tidewater was reduced to $16, in order to check the competition of Southern and Western producers. Considerable Alabama iron had been sold on the basis of Thomas iron prices, the buyer being guaranteed a margin under the Thomas quotation no matter what that might be.[36] Western rail mills were in difficulties. The Union Steel Company of Chicago declared no dividends, its rail mills having been shut down a considerable portion of the year; and the Western Steel Company, lessee of the Carondolet furnaces and mills near St. Louis, terminated its lease, partly because the operation of the plant had ceased to be profitable.[37] This was a year of tariff uncertainty and business was disturbed by the Presidential election.

During these years of fluctuating prosperity in America, following the boom of 1886, the iron and steel makers of Europe were enjoying a prolonged era of active demand and remunerative prices. Between 1883 and 1886 they had experienced a serious depression, and their recovery was due in no small degree to the heavy importations of the United States in 1886 and 1887. But the revival abroad continued longer than in America. Germany and Austria had recently increased their tariffs on iron and steel; large development enterprises were under way in South America and the colonies; and the British Navy was giving unusually large orders to the steel makers of that country. So prices abroad continued to advance. In 1889 steel rails were higher in Germany than in the United States, although decidedly lower than in Great Britain.[38]

[35] American Iron and Steel Association, *Bulletin*, XXI, 116, May 4, 1887; XXI, 300, Oct. 26, 1887.

[36] American Iron and Steel Association, *Bulletin*, XXII, 109, 110, Apr. 4, 1888; XXII, 166, May 23, 1888.

[37] American Iron and Steel Association, *Bulletin*, XXII, 147, May 9, 1888; XXII, 194, June 20, 1888.

[38] American Iron and Steel Association, *Bulletin*, XXIII, 108, Apr. 17 and 24, 1889.

LOW-PRICE ERA OF THE EARLY NINETIES

Meanwhile the United States was entering a period of unprecedentedly low prices for pig iron and steel. Early in 1889 the Thomas Iron Company fixed its opening price on gray forge pigs at $15.30. Southern iron was placed on private terms, presumably to meet these prices. During the ensuing flurry, less-established Southern brands sold as low as $14.50. Nevertheless, the market was not panicky, probably because costs of production were adjusted to these low quotations. Evidently furnace owners were not losing money, for their output did not decline materially. In 1889 the Pittsburgh district, which had produced more pig iron the previous year than in 1887, was fully as active as during the preceding season.[39] By July there was a sharp upward turn in the market, although the advance in prices proved to be neither pronounced nor consistent. Cheap iron was apparently stimulating consumption. Legitimate buyers could procure as much iron as they required, but outsiders and speculators had difficulty in placing large orders. Twenty-nine furnaces with a capacity of over 1,200,000 tons were under construction, and a few enthusiasts anticipated that American furnace owners would soon be exporting to Great Britain, where both iron-makers and consumers had been caught unprepared by an exceptional demand.[40]

A hopeful sentiment greeted the advent of 1890. The president of the Thomas Iron Company reported that his firm, which was the largest individual producer of high-grade Eastern irons, had declined an offer of $20 a ton by an English dealer for its entire output during the coming season. In the course of the previous six months that Company sold more iron and made more money than in any other equal period in its history. The stock of iron on hand in the country was very low. Yet irregularities speedily developed in the market which caused more or less uneasiness and improvement was neither as rapid nor as pronounced as had been anticipated. The enormous productive capacity of the country was responsible for some of this timidity, both sellers and purchasers fearing that an abrupt rise of prices would precipitate overproduction and a sudden slump.[41] More iron and steel were produced in 1890 than in 1889, and by the close of the year prices of leading iron and steel products had fallen to a lower point than they had ever previously reached except during very acute depressions. Bessemer pig was quoted at $16.50 a ton, and steel rails at $28.50 a ton, in the Pittsburgh market.[42]

In 1891 an unprecedented shrinkage in the volume of business occurred during the first half of the year, and a recovery almost equally remarkable during the second half. January opened with low prices and disturbances

[39] American Iron and Steel Association, *Bulletin*, XXIII, 46, Feb. 13, 1889; XXIII, 134, May 15, 1889; *Commercial and Financial Chronicle*, XLVIII, 740–741, June 8, 1889.

[40] American Iron and Steel Association, *Bulletin*, XXIII, 190, July 10, 1889; *Commercial and Financial Chronicle*, XLIX, 631–633, Nov. 16, 1889.

[41] American Iron and Steel Association, *Bulletin*, XXIV, 28, Jan. 29, 1890.

[42] American Iron and Steel Association, *Bulletin*, XXIV, 372, Dec. 31, 1890.

in the labor market. The coal miners of Alabama were on strike and several furnaces in that state were banked. The furnace owners of the Shenango and Mahoning Valleys closed their furnaces on the tenth of January until better freight rates and lower ore prices could be obtained. Altogether 25 furnaces in this region and an equal number in Alabama were idle for these causes. In addition, the miners and coke workers of the Connellsville region went on strike on the ninth of February, so that production was generally checked in this district until the following May. The Mahoning agreement restricted production of pig iron in that Valley until June.

At the time these events tended to cause optimism rather than the reverse, since they indicated an enforced decrease in production, with the probability that when the furnaces resumed they would be favored with lower operating costs. Counteracting this sentiment to some extent was the prevailing impression that the country as a whole was entering upon a period of liquidation which must continue for some time. Although the output of pig iron was thus abruptly reduced, there was a coincident depression in prices, due mainly to a slack demand from the railroads. These were directly affected by the prevailing financial stringency, which prevented them from placing their securities, while at the same time traffic fell off heavily on account of short crops and monetary unsettlement. Raw material prices were, in the opinion of prominent iron makers, unduly inflated, while output had increased beyond the consuming ability of the country.[43] Andrew Carnegie declared in an interview given in March 1891, that the high ore prices then prevailing were due to the mistaken notion that the country could not furnish enough ore, iron and steel to supply the nation's need at a time when Europe was fully occupied with its own demands and those of the rest of the world.[44] Nevertheless the furnaces and steel works of the United States had not only met this demand but had overleaped it. The total effect of the curtailment that now resulted was a falling off in the production of pig iron of 1,331,219 tons, or 26 per cent, as compared with the first six months of 1890. As we have noted elsewhere, even the reaction following the panic of 1873 was not nearly so severe, for the curtailment of output at that time occurred more slowly, the total decline for the ensuing three years amounting only to 27 per cent, or one per cent more than the decline within six months in 1891.[45]

This period of sharp curtailment was followed by an equally marked recovery later in the season, but in January 1892 a serious break occurred in the price of structural steel, followed in February by a like decline in the price of barbed wire. In both of these cases, however, quotations had been maintained by artificial methods which proved inadequate to resist the logic of actual trade conditions. Throughout this low-price era,

[43] American Iron and Steel Association, *Bulletin*, XXV, 12, Jan. 14, 1891; XXVI, 133, May 11, 1892; *Commercial and Financial Chronicle*, LIII, 108–110, July 25, 1891.
[44] American Iron and Steel Association, *Bulletin*, XXV, 74, Mar. 18, 1891.
[45] *Iron Age*, LIX, 9–12.

which had not yet run its course, the pig-iron market was steadily subjected to a strain of exceptional severity by the pressure of Southern competition. The aggregate capacity of the coal and charcoal furnaces south of the Potomac now exceeded 3,000,000 tons per annum and costs of production in that region were very low. Consequently there was no immediate prospect of higher prices for pig iron, nor was the industry likely to recover its normal psychology until producers had reconciled themselves to making iron at a lower cost and on a narrower margin of profit than during the years immediately preceding.[46]

This situation weighed especially heavily upon manufacturers of wrought iron, whose business was becoming precarious enough at best. In the early winter of 1892 puddling furnaces were shut down at Pittsburgh in rapid succession, and the puddlers who received their discharge were advised to seek work elsewhere as the prospect of an early resumption was very slight.[47] During March, according to rumor, gray forge iron was sold for less than $9 a ton at Birmingham, and was regularly quoted at $9.25. The best brands were sold freely at $12. Yet in spite of these low prices the output of pig iron continued to increase.[48] Furnace districts that procured their supplies from a distance suffered more from this situation than those controlling their own iron and coal in their immediate vicinity. The Shenango and Mahoning Valley furnaces in particular were at the mercy of the ore producers of the Lake Superior region. Their ore contracts were generally made for the season at rates that they could not afford to pay when the price of the iron they made was falling steadily.

Notwithstanding these conditions, when the figures for the first half year of 1892 were compiled they showed that the production had been larger than in any other six-month period in the history of the industry, and far larger than in the corresponding six months of the previous year. More important still, consumption was evidently increasing rapidly under the stimulation of low prices. In fact, the unsatisfactory state of the industry, so far as it existed, was due rather to unremunerative prices than to slack demand. In 1891 prices declined notwithstanding a heavy reduction of output; in 1892 they declined during a great expansion of output and when consumption was keeping approximate pace with the increase in production.[49]

Naturally this rapid growth in blast furnace capacity could not continue. Indeed, it was due in part to the blowing in of new furnaces started during previous periods of higher prices. By the summer of 1892 new furnace construction was almost at a standstill and the growth in output which had characterized the previous months was brought to a sudden stop. At the same time industries consuming pig iron were overtaking the working

[46] American Iron and Steel Association, *Bulletin,* XXVI, 133, May 11, 1892.
[47] American Iron and Steel Association, *Bulletin,* XXVI, 61, Mar. 2, 1892.
[48] American Iron and Steel Association, *Bulletin,* XXVI, 78, Mar. 16, 1892.
[49] *Commercial and Financial Chronicle,* LV, 127–128, July 23, 1892.

capacity of the furnaces. New sheet mills, tin plate mills, wire works and machine shops were being opened. The growth in the demand for wire rods in the northwestern states alone was estimated at 75,000 tons a year, and tin-plate mills expected to increase their consumption by 100,000 tons the following season. Commenting upon the general condition of the market in the autumn of 1892, an authority observed:

"It seems almost incredible that only three years ago the great steel works of the country were supposed by their managers to be threatened with a shortage in the supply of pig iron needed for visible requirements. Since then the supply of pig iron has so greatly increased that the question is often asked, Will consumption ever catch up to anything like the production?"

In spite of low prices it was said that—

"discreet producers object to raising pig iron above $14.75 or $15, which pays reasonable profits; anything beyond reasonable returns promotes competition that demoralizes business."[50]

Some of the pessimism which prevailed among iron manufacturers this season was due to the check to world prosperity. The first marked symptom of this was the Baring failure in London in 1890. A premonition of the crisis that was to follow in America three years after that event may have been already in the air, although not consciously entertained. Some surprise was apparent when, as 1892 wore on, it was discovered that the textile, pottery, glass and other leading industries were fully employed at fairly remunerative prices. It puzzled producers to observe that the price of iron and steel fell to a lower average level in 1892 than had ever before been known, in spite of the fact that in several lines consumption was the largest in the country's history. In the opinion of the men engaged in the industry, it was not prosperous although it was very active. Neither, upon the whole, was 1892 a favorable year for Western farmers. The aggregate yield of the grain harvest was smaller than usual, and the price of wheat was lower than for several seasons. There was a similar decline in the cotton crop, though in this instance prices had risen.[51]

CRISIS OF 1893

During the first half of 1893 little change occurred in the condition of the iron and steel market. Producers were sold well ahead, but Southern irons were too plentiful to permit an advance in quotations. By midsummer the situation was decidedly less hopeful. In May the Joliet Steel Works shut down entirely.[52] Stocks began to accumulate by the middle of the year, and the first six months closed upon an unpromising situation, although the volume of business during the preceding six months had been nearly the largest on record. Before July was over the demoralization of

[50] *Iron Age*, quoted in American Iron and Steel Association, *Bulletin*, XXVI, 275, Sept. 21, 1892; *Mineral Industry*, I, 306.

[51] American Iron and Steel Association, *Bulletin*, XXVII, 108, Apr. 12, 1893.

[52] American Iron and Steel Association, *Bulletin*, XXVII, 140, May 10, 1893; XXVII, 157, May 24, 1893.

the market was complete. The big mines of the Lake Superior region had begun to shut down, Lake freights were growing weaker, and although docks were being rapidly cleared of last season's ore, little new ore was coming in. This month many large works suspended operation. These included the Bessemer Steel Department of Jones and Laughlin; two of the furnaces of the Pennsylvania Steel Company; and three of the furnaces of the Carnegie Steel Company; besides numerous shut-downs and curtailments at smaller plants. The wire-nail manufacturers decided in July to close their works until September. This period of maximum depression lasted until late autumn, but by November output again began to increase. This season practically all additions to the active furnace capacity were confined to plants connected with rolling mills and steel works in the Central West. The stock of pig iron on hand November first—both sold and unsold—exceeded 838,000 tons.[53]

Many companies were unable to weather this crisis. On June 28, 1893, the *Bulletin* of the American Iron and Steel Association published a list of 32 failures in the iron trade since the first of the previous January, denominating those six months as the most disastrous in the history of the business. Among the more important firms which went into the hands of receivers at this time were the Philadelphia and Reading Coal and Iron Company, operating six furnaces and a rolling mill; the Pennsylvania Steel Company, operating four blast furnaces, Bessemer and open-hearth steel works, and an extensive rolling mill; and the Maryland Steel Company, virtually all the stock of which was owned by the Pennsylvania Company. The last-mentioned corporation owned four blast furnaces, Bessemer steel works and a rolling mill at Sparrows Point. On August 17, the Oliver Iron and Steel Company of Pittsburgh passed into the hands of a receiver, the first instance of this kind which had occurred in that district. Among other important failures was that of the West Superior Iron and Steel Company, which carried down with it the Minnesota Blast Furnace Company and the Wellman Iron and Steel Company near Chester, Pennsylvania. About this time the once great Vulcan Works at St. Louis were dismantled.[54]

In the very midst of this depression, however, some plants which had closed down resumed operations. The majority of the departments of the Jones and Laughlin Company were running by the middle of August. About the same time all the furnaces of the Tennessee Coal, Iron, and Railroad Company at Bessemer, Alabama, went into blast, and the steel plant of the Colorado Fuel and Iron Company resumed operations with a full force of men and orders ahead which it was reported would employ its work continuously for a year.[55]

[53] American Iron and Steel Association, *Bulletin*, XXVII, 206, July 5 and 12, 1893; XXVII, 229, Aug. 2, 1893; XXVII, 365, Dec. 20 and 27, 1893.
[54] American Iron and Steel Association, *Bulletin*, XXVII, 197, June 28, 1893; XXVII, 251, Aug. 23, 1893; XXVII, 301, Oct. 11, 1893; XXVII, 315, Oct. 25, 1893.
[55] American Iron and Steel Association, *Bulletin*, XXVII, 236, Aug. 9, 1893; XXVII. 245, Aug. 16, 1893.

CHAPTER XXVI

MARKETING METHODS AND FOREIGN COMPETITION

TARIFF ON IRON AND STEEL

During this period practically all the great industries of the United States were deeply concerned in tariff legislation, and much of the trade and technical literature of such industries is colored by more or less overt propaganda in favor of protection. To be sure movements occasionally manifested themselves, though always on a local and limited scale, in favor of free trade or low customs duties on particular raw materials. In 1874 an agitation, said to have been fathered by the officers of the Douglas Axe Company of Massachusetts, was started for the purpose of securing the removal of duties upon English steel, and for a brief period the controversy over the issue was acrimonious.[1] During the heated political campaigns of the eighties, iron and steel manufacturers, and especially makers of steel rails, were charged with expensive and improper lobbying at Washington; and such lobbying occurred, although the charge that corrupt methods were used seems not to have been substantiated.[2]

Among the constant sources of complaint on the part of manufacturers were the rulings of the Treasury Department interpreting the tariff law, and amendments to the existing legislation were repeatedly proposed for the purpose of rectifying what were considered unfriendly decisions by that department. To such decisions were attributed in 1883 the death of the nascent tin-plate industry, the depression of the cotton tie and the wire-rod industry, and the growing importation of Bessemer and open-hearth steel blooms from Great Britain. Nevertheless the new law enacted that year not only confirmed previous Treasury rulings on these items, but reduced existing iron and steel duties.[3] It was argued that the large importation of pig iron in the late eighties was encouraged by a reduction of the duty from $7 to $6.72 a ton in 1883, and that to lower it still further, as was proposed five years later in the Mills Bill, but was never done, would greatly facilitate the importation of foreign iron.[4] As a matter of fact the key duties on iron and steel were always specific, and were not materially lowered during the twenty years we are discussing; but during that interval,

[1] American Iron and Steel Association, *Bulletin*, VIII, 129, 132, Apr. 23, 1874.
[2] *Cf.* American Iron and Steel Association, *Bulletin*, XVI, 4, Jan. 4, 1882.
[3] American Iron and Steel Association, *Bulletin*, XVII, 75–76, Mar. 14 and 21, 1883.
[4] American Iron and Steel Association, *Bulletin*, XXII, 140, May 2, 1888.

as we have just seen, the price of iron and steel products, thanks chiefly to improvements that lowered the cost of production and to the discovery and development of new supplies of raw materials, fell rapidly. Therefore the amount of protection afforded by these duties tended to increase, and it was relatively highest during periods of depression and low prices. Furthermore the westward trend of iron and steel making during these years, in response to the pull of the Lake Superior and Alabama ore districts and of the growing interior market, still further protected the chief center of the industry from foreign competition.[5]

IRON-WARRANT SYSTEM

Methods of marketing pig iron in the United States have been different from those common in Great Britain. In the latter country it has been the custom since before 1850 for furnace owners to store their surplus with a warehousing firm making a specialty of the business, and to receive warehouse certificates, or "pig-iron warrants," upon which they could borrow money if they so desired. This system had certain distinct advantages. It was claimed to be a regulator of the market, and the fact that iron and steel prices did not fluctuate as rapidly and widely in Great Britain as in the United States was attributed to this method of handling iron in the former country. A much larger quantity of pig iron was kept on hand in Great Britain than in the United States. One may reasonably question whether the relatively steadier prices and larger stocks in Great Britain were not due partly, and perhaps mainly, to the fact that that country served a great export market, rather than to the use of storage warrants. However that may be, the example of Great Britain, and the convenience or fancied convenience of some American furnace owners, suggested the introduction of the warrant system in the United States. The first formal step in that direction was taken in 1874 by the Pennsylvania Warehousing and Safe Deposit Company, which planned to open special iron yards at several convenient shipping and marketing points, beginning with Allentown, Pennsylvania, where it received pig iron for storage and issued warehouse receipts against it. The idea was, of course, that as in Great Britain these receipts would be negotiable and might serve as security for loans. This company proposed to handle each consignment of iron placed in its keeping as an individual lot, and to assume no responsibility for grading and but a qualified responsibility for weight, although there were weighing charges both when the iron was received and when it was shipped. Six years later, the Union Storage Company was organized at Pittsburgh to engage in the same business. Two iron and metal exchanges, subsequently amalgamated, existed in New York, which proposed to handle pig iron as a speculative commodity through the hands of brokers.[6]

[5] *Cf.* Taussig, *Tariff History of the United States*, 244, 270–271; Stanwood, *American Tariff Controversies*, II, 219.

[6] American Iron and Steel Association, *Bulletin*, VIII, 400, Dec. 31, 1874; IX, 348, Nov. 19, 1875; XIV, 251, Oct. 13, 1880; XVI, 195, July 19, 1882; XVII, 100, Apr. 11, 1883; XVII, 173, June 27, 1883; XVII, 289, Oct. 17, 1883.

These early attempts at trading in iron through warrants and on the floor of exchanges were vigorously opposed by a majority of American furnace men and iron manufacturers. Several conditions adverse to this system existed in the United States that did not exist in England, and especially in Scotland, where it had its strongest foothold. Our furnaces were scattered over a vastly larger area, and their market was both limited and protected by this geographical condition. Transportation charges were a larger percentage of consumers' costs in America than in Great Britain, and the most economical route from furnace to foundry or rolling mill did not always pass through a storage center. A traditional prejudice existed against buying iron, especially in view of the wide variety of kinds and qualities produced in a great country like the United States, except from the original maker. It was rapidly becoming the rule for the largest iron and steel-making companies to own or control all the processes of production from extracting ore and fuel to shipping the finished product. Such companies had no occasion either to store pig iron or to purchase it from warehousing companies. When they did buy pig iron it was usually in large lots, and frequently on long-term contracts, directly from the maker. Neither was it customary to carry heavy stocks of unsold iron. In periods of activity our furnaces were fully occupied supplying the needs of the moment; in periods of depression they were accustomed to cease operations. To be sure, these alternations of activity and idleness or semi-idleness were not economical, and one of the strong arguments in favor of the warrant system was that it would create a series of reservoirs to equalize flood and drought periods of iron production, so that prices would be stabilized and the necessity of shutting-down furnaces would be obviated. Still, the facts that the storage yards could handle only foundry and miscellaneous irons inasmuch as the market for Bessemer pig was concentrated in the hands of a limited number of consumers and producers, that consumers had a traditional preference for buying their iron from particular furnaces, and that a widespread prejudice existed against any institution likely to introduce new speculative features into the iron trade, prevented the growth of the warrant system. The New York Iron and Metal Exchange was looked upon as an agency for depressing prices and was suspected by many iron masters of being under the control of a bear clique.[7]

Notwithstanding this the American Pig Iron Storage Warrant Company, with a capital of $2,000,000, was organized in 1889 in the face of much opposition. Although its business at first was light, the quantity of iron held at its yards increased slowly but steadily until it amounted to several hundred thousand tons. That, however, was a development postponed until after the period we are now discussing. This company, which utilized to some extent the facilities of the old local warehousing companies already

[7] American Iron and Steel Association, *Bulletin*, XVII, 289, Oct. 17, 1883; XXIII, 42, Feb. 13, 1889; XXIII, 60, Feb. 27, 1889; XXIII, 68, Mar. 6 and 13, 1889; XXV, 4, Jan. 7, 1891; *Commercial and Financial Chronicle*, XLVIII, 384–385, Mar. 23, 1889.

mentioned, was promoted mainly by southern iron masters, who sought some device that would enable them to borrow money on their storage stocks, and who, since they produced mainly foundry iron, distributed to a larger number of consumers than the great Bessemer furnaces of the North. These differences in market probably explain why the southern furnaces resorted so largely to the warrant system while those of the Mahoning and Shenango Valley utilized it practically not at all.[8]

EXPORTS AND IMPORTS

Although the United States became the largest iron and steel-producing country in the world during this period, passing Great Britain in output of Bessemer steel rails in 1879, in output of steel ingots in 1884, and in both aggregate production of all kinds of steel and total output of pig iron in 1890, and though it was surpassed by Great Britain only in the production of open-hearth steel, the product of American furnaces and rolling mills was mostly consumed at home. The foreign iron and steel trade of Great Britain and also of Germany, which was rapidly overtaking Great Britain in this group of industries and ranked third among the iron and steel-making nations of the world, far exceeded our own, although we exported some machinery and occasionally small lots of special irons, particularly of charcoal pigs. In 1875 a New York company shipped a small lot of anthracite iron to Bremen, and the same year larger consignments of charcoal iron were imported into England from Alabama, though at not very profitable prices for the producers. A small shipment of Texas pig iron went to England the same year. Charcoal iron was imported by the British for special uses, particularly the manufacture of light castings, for which the common irons of their own country were not suitable. Sweden and other countries making charcoal iron competed with the United States for the British market, since very little iron of that character was made in the latter country. American charcoal iron shipments continued throughout the period we are discussing, though they never attained more than microscopic dimensions compared with our total output. In 1885 the only maker of charcoal iron in Great Britain was said to be a Scotch firm, which, though its production was limited, claimed to ship part of its product to America. At this time Michigan charcoal iron was being regularly imported by British manufacturers for making malleable castings, the Elk Rapids Iron Company of that state being the principal producer in this field, and a single firm in Derby, England, being the importer. Between 1887 and 1892 some 5,000 tons of charcoal pig was shipped from the former to the latter company.[9]

[8] American Iron and Steel Association, *Bulletin,* XXIII, 29, Jan. 30, 1889; XXIII, 35, Feb. 6, 1889; XXIII, 293, Oct. 23, 1889; XXV, 77, Mar. 18, 1891.

[9] American Iron and Steel Association, *Bulletin,* IX, 68, Mar. 12, 1875; IX, 234, Aug. 6, 1875; X, 52, Feb. 16, 1876; XII, 153, July 3, 1878; XIX, 245, Sept. 9, 1885; XIX, 277, Oct. 14, 1885; XIX, 293, Nov. 4, 1885; XXII, 229, July 25, 1888; XXVI, 341, Nov. 23, 1892.

Our exports of manufactured iron and steel were due chiefly to the special adaptation of certain types of American tools and machinery for colonial and other foreign uses, and to the cheap quantity production of patented articles in the United States. Agricultural machinery, sewing machines, firearms, special castings, bridges, machine tools, locomotives and sugar mills were exported with fair regularity as early as 1874; so were scales, stationary engines, stoves and other articles, the manufacture of which had been specialized and improved in America until they were definitely superior to those made by competing nations. At a comparatively early date we began in isolated instances to ship rails abroad. As early as 1877 our makers apparently took away from their British rivals a contract for steel rails to be delivered at Rio de Janeiro, and in 1885 almost every ship of the United States and Brazilian Steamship Company sailing from our ports was said to carry locomotives, structural steel and barbed wire to South America. The Babcock and Wilcox Company likewise filled many foreign orders for its boilers at this time as well as later.[10]

Measured by value, however, our exports of iron and steel and their manufactures remained practically stationary from 1871 to 1886; and in both of these years they totalled less than $15,000,000. After 1886 they increased rapidly, more than doubling during the following half decade. Machinery always constituted the principal item in this trade, followed by builders' hardware and sewing machines.[11]

Naturally our imports of both pig iron and of its manufactures greatly exceeded our exports. This was due to the extreme and sudden fluctuations of the demand in America as much as to any advantages that British and other foreign producers may have enjoyed in the way of lower costs. In 1879, during the first marked revival after the panic six years before, the Edgar Thomson Steel Company bought 10,000 tons of Bessemer pig iron in England, and the following year what was referred to by alarmed iron masters in America as "a deluge of foreign iron" flooded our ports. Within a single week no fewer than twenty vessels loaded in part with pig iron entered New York harbor. Though most of these came from Great Britain, there were consignments of scrap iron from Baltic, Channel and Mediterranean ports, and even from far-off Odessa. By July 1880 it was estimated that 225,000 tons of foreign ore were stored in New York and vicinity. American consumers were reported at this time to give preference to domestic irons at equal prices, since they were of familiar and guaranteed qualities; nevertheless our total imports of iron and steel in unmanufactured and partly manufactured form rose from 250,000 tons in 1879 to almost 1,850,000 tons in 1880. During the same period our imports of manufactures of iron and steel more than doubled in value. So large

[10] American Iron and Steel Association, *Report of Secretary for 1875*, pp. 22–23; *id.*, *Bulletin*, x, 138, May 10, 1876; xi, 161, June 13 and 20, 1877; xiii, 130, May 31, 1879; xix, 50, Feb. 25, 1885; xxii, 77, Mar. 7, 1888; xxii, 229, July 25, 1888.

[11] American Iron and Steel Association, *Bulletin*, xxx, 5, Jan. 1, 1896.

were the stocks of foreign iron held in New York that the bonded warehouses could not accomodate them, and many shippers were obliged to pay duty and place their consignments in unbonded storage.[12]

This situation led to some ill feeling between American furnace owners and the larger Bessemer steel companies. Furnace men claimed that the latter showed a preference for imported iron. This elicited formal denials over the signatures of the managers of several important works, to the effect that they did not show such a preference to foreign makers, but on the contrary paid a premium, in some instances of $4 or $5 a ton, for American iron above the cost of that imported. It is to be noted, however, that some big companies did not express themselves upon this point. Indeed, steel makers claimed that the furnace men themselves were using foreign ores, thus discriminating against domestic mines, and therefore were not in a position to protest against the employment of imported pigs in our Bessemer converters.[13]

With the growth of open-hearth steel furnaces in America, a new influence manifested itself in the import trade. Ordinary Bessemer pig iron could not be imported for any length of time in competition with the domestic article, but special qualities of iron for use in open-hearth steel furnaces were not always to be had in this country and their importation, and that of scrap, was inevitable until this need was met. American Bessemer works continued also to bring spiegeleisen and ferromanganese from abroad, although their production in America was increasing. Scotch pig for foundry use held a place in the American market until after 1880, though a much smaller one than a few years previously.[14] By 1886, however, Southern foundry irons were rapidly displacing them, although total imports of pig iron were larger that season than for several years previously, rising to more than 228,000 tons. It was this year that our imports of iron ore suddenly increased within twelve months from less than 400,000 tons to well over 1,000,000 tons.[15]

Ocean freight rates naturally had some part in determining the ebb and flow of these importations. In 1885 the surplus of east-bound tonnage was so large that sailing vessels carried spiegeleisen in large quantities from Antwerp to Philadelphia as ballast, the only expense to the shipper being the cost of loading and discharging the cargo.[16] Plant location naturally had an important bearing upon the source from which steel makers and manufacturers drew their raw materials. The principal market for Scotch

[12] American Iron and Steel Association, *Bulletin*, XIII, 283, Nov. 5 and 12, 1879; XIV, 33, Feb. 11, 1880; XIV, 161, July 7, 1880; XIV, 171, 173, July 14, 1880; XIV, 228, Sept. 15, 1880; XV, 57, Mar. 2 and 9, 1881; National Association of Wool Manufacturers, *Bulletin*, XII, 184 (footnote), June 1882.

[13] American Iron and Steel Association, *Bulletin*, XV, 164, June 29, 1881.

[14] American Iron and Steel Association, *Bulletin*, XVIII, 253, Oct. 1, 1884; XIX, 325, Dec. 2 and 9, 1889.

[15] American Iron and Steel Association, *Bulletin*, XX, 189, July 21, 1886; XXI, 36, Feb. 9, 1887; XXI, 164, June 22, 1887.

[16] American Iron and Steel Association, *Bulletin*, XIX, 253, Sept. 16 and 23, 1885.

foundry irons and British Bessemer pig had always been near to the Atlantic Coast. In 1887 the Roane Iron Company of Chattanooga purchased a few thousand tons of Bessemer iron from England, because the Southern furnaces could not at that time supply pig of the quality it needed and similar iron did not chance to be available in the North. That year British exporters remarked the heavy shipments of scrap iron to the United States, which measured the growth of open-hearth steel making in this country. The total imports of iron and steel in 1887 were nearly 100,000 tons greater than in 1885 and 1886 combined, rising to 1,783,000 gross tons, and imports of iron ore also increased. But importations of pig iron never again attained the figure of 1880 and 1882, and they fell off markedly in the years immediately succeeding, as did likewise aggregate iron and steel imports.[17]

Although the United States was rapidly becoming the largest producer of steel in the world, American manufacturers continued to import not only special grades of cutlery steel, but also blooms and billets. In 1879 the St. Albans Iron and Steel Works in Vermont were reported to be rolling rails from English blooms. A few years later it was noted that our imports of basic steel billets and wire rods from Germany were increasing, and that this soft steel was taking the place of Norway or Swedish iron formerly used in New England for making nail plates, tack plates and nails, as it cost only half as much as Swedish bars delivered. This steel was also replacing American puddled iron and it was used even as far west as St. Louis by manufacturers of stamped goods and enamel ware. Imports of rails from abroad, especially Great Britain, continued to be relatively large whenever a sudden increase occurred in railway building.[18]

COMPARATIVE CONDITIONS AT HOME AND ABROAD

Although British makers could produce iron and steel cheaper than those of America, competitive conditions tended to become more equal in the two countries. In 1874 an American metallurgist asserted that the English furnace owner had an advantage of from \$3 to \$5 a ton on pig iron in the matter of labor alone. He secured further economies through the larger size of his establishment, his systematized administration and quantity production. His furnaces were technically superior to those in the United States, his capital was larger and his interest charges lower.[19] Only seven years later London *Engineering* complained that American steel makers were beating those of Great Britain by 100 per cent in the output of their converters, and much the same situation prevailed in respect to rail, bar and sheet mills. This was attributed to some extent to better organization,

[17] American Iron and Steel Association, *Bulletin*, XXI, 28, Feb. 2, 1887; XXI, 85, Mar. 30, 1887; XXI, 93, Apr. 6, 1887; XXI, 220, Aug. 19, 1887; XXII, 60, Feb. 22, 1888; XXIII, 139, May 22 and 29, 1889; *Commercial and Financial Chronicle*, LXII, 1117, June 20, 1886.

[18] American Iron and Steel Association, *Bulletin*, XIII, 121, May 21 and 28, 1879; XIII, 261, Oct. 15, 1879; XIII, 307, Dec. 3, 1879; XIX, 308, Nov. 18, 1885; XX, 314, Dec. 1, 1886.

[19] American Iron and Steel Association, *Report of Secretary for 1875*, p. 20; *cf. id., Bulletin*, XIV, 147, June 16, 1880.

and more largely to better plants. The drill of the men was perfect. This straining after high output had proved to be economical. An American furnace of the same size produced twice as much iron as a Cleveland furnace in Great Britain. Rather oddly, in contrast with conditions ten years before, British plants were criticized as backward in comparison with the American and the hot-blast stoves in use in the two countries were cited as evidence of this.[20] Ten years later Sir James Kitson, writing in the *Contemporary Review*, commented on the higher output and in many instances the better arrangement of American plants. He argued that the Americans had not invented much that was important, but that they had improved upon ideas which were in the first instance of English origin. Studying their competitors abroad in a way that British makers would not deign to study their competitors in America, they profited by the errors of their rivals and, supplementing the experience of the latter by their own ingenuity, they had made their plants models of arrangement and efficiency.

"Their blast furnaces are more capacious than ours, their engines are more powerful, their rolling mills are of new improved construction. The high standard of education, and especially of the technical education of the people in America, undoubtedly is much to their advantage."[21]

[20] Quoted in American Iron and Steel Association, *Bulletin*, XV, 42, Feb. 16, 1881.
[21] *Contemporary Review*, LIX, 640, May 1891, quoted in American Iron and Steel Association, *Bulletin*, XXV, 147, May 20, 1891.

CHAPTER XXVII

ARMOR, ORDNANCE AND SHIPS

MANUFACTURE OF ARMOR PLATE

For more than a decade after the Civil War foreign governments frequently turned to the United States for firearms. After that, although our exports of military supplies and munitions continued to be of some importance, they ceased to attract public notice. Between 1874 and 1879 the Providence Tool Company filled for the Turkish Government what was said to be the largest contract for small arms ever given to a private armory. This was for 650,000 Martini-Henry rifles, which were manufactured at the rate of a thousand per day. The Winchester Arms Company had a contract with the same government for 300,000,000 cartridges, the two orders aggregating over $20,000,000.[1] These industries received little domestic encouragement, however, as a long naval and ordnance holiday followed the heavy military expenditures of the Civil War, and for nearly two decades practically no interest was exhibited either by the Government or by the public in big guns or fighting ships. Not until 1883, when the building of the "New Navy" was undertaken, did Government contracts again begin to figure in the calculations of iron and steel makers; and it took well toward a decade thereafter to place the United States on something approaching an equal footing with Great Britain, France and Germany in this field of manufacturing. In the autumn of 1883, when bids were opened at the Navy Department in Washington for armor plates for the turret of the monitor *Miantonomah*, the only offer from an American firm made no pretense of conforming with the conditions set by the Department, and the successful bidder was the agent of a Sheffield manufacturer.[2]

Three years later the Carnegie Company began the erection of an armor-plate plant in connection with its new open-hearth steel works at Homestead. The mills were designed to make armor plate for war vessels, though it was not assumed that they would be devoted mainly to that object. The same year the Bethlehem Iron Company erected what was considered in that day a gigantic rolling mill, in connection likewise with open-hearth steel works, having its eye on possible contracts for armor plate and heavy ordnance. On June 1, 1887, this Company received the first con-

[1] American Iron and Steel Association, *Bulletin*, XI, 44, Feb. 14, 1877; XIII, 187, July 23 and 30, 1879.

[2] American Iron and Steel Association, *Bulletin*, XVII, 293, Oct. 17, 1883; XVII, 309, Nov. 7, 1883.

tract for steel armor given to an American firm by the Navy Department, together with a contract for furnishing about 1,300 tons of steel gun forgings. Only three American steel works bid for the gun forging contracts—the Bethlehem, Midvale and Cambria Companies, and but two firms—the Cleveland Rolling Mill and the Bethlehem Iron Company bid for the armor plate. The same year the Linden Steel Works near Pittsburgh rolled light armor plates for the new cruisers then under construction; and by 1889 the Homestead Mills were rolling 3-inch plates, weighing 15,200 pounds.[3]

Meanwhile American engineers made rapid progress in the production of alloys and specially treated surfaces that added greatly to the resistance of armor plates, so that those produced in this country were perhaps the best then manufactured in the world. In 1881 three Navy tests of American armor were made at the Annapolis Naval Proving Grounds. Steel plates were shattered and nickel plates were perforated, but the Harvey nickel plates pulverized the projectiles and remained comparatively uninjured. The last-named process was developed by the Naval Ordnance Bureau, and has already been described in another connection. It consisted essentially in treating the completed plate with carbon at sufficiently high temperatures to add to the carbon content of the surface, by something not unlike the old cementation process, until the outer layer of the plate could be hardened and tempered by sudden chilling and annealling. The product, being backed by the softer steel of the center of the plate, had a much higher resisting power than ordinary armor.[4] In 1891 a British trade periodical observed that the United States had recently exceeded even its rapid strides in other departments of iron and steel manufacture in the production of war materials. New and more powerful rolling mills were constantly added to the larger American plants. In 1891 the Carnegie Works were able to roll nickel-steel ingots weighing 50 tons, an exploit that probably could not have been equaled by the French manufacturers who invented this process. Makers had not been able, hitherto, to bend these exceedingly heavy plates. That year, however, armor plate was successfully curved, treated by the Harvey process, and tempered at the Bethlehem Works. Within less than a decade the United States had advanced from a position where it was entirely dependent upon Europe for heavy steel armor equal to that used upon foreign vessels, to a position where it was capable of supplying all its requirements.[5]

[3] American Iron and Steel Association, *Bulletin*, xx, 77, Mar. 24, 1886; xx, 333, Dec. 15, 1886; xxi, 107, Apr. 20 and 27, 1887; xxi, 277, Oct. 5, 1887; xxiii, 269, Sept. 25, 1889; xxxi, Suppl., 5, Dec. 10, 1897; *cf. Boston Journal of Commerce*, xl, 310, Aug. 20, 1892.

[4] American Iron and Steel Association, *Bulletin*, xxv, 141, May 13, 1891; xxv, 147, May 20, 1891; xxv, 325, Nov. 4, 1891; *Engineering Magazine*, xii, 838–845, Feb. 1, 1897.

[5] *London Coal and Iron Trade Review*, quoted in American Iron and Steel Association, *Bulletin*, xxv, 162, June 3, 1891; xxv, 301, Oct. 14, 1891; xxvi, 109, Apr. 20, 1892; xxvi, 298, Oct. 12,
xxv, 162, June 3, 1891; xxv, 301, Oct. 14, 1891; xxvi, 109, Apr. 20, 1892; xxvi, 298, Oct. 12,
1892; *Iron Age*, xlvii, 523–524, Mar. 19, 1891; xlvii, 1069–1073, June 4, 1891; *Engineering Magazine*, iv, 768–780, Sept. 1893.

MANUFACTURE OF ORDNANCE

The history of the manufacture of steel ordnance in the United States runs closely parallel with that of armor. During the Civil War, it will be remembered, all the heavy ordnance used by the Union forces and the Confederates was cast iron, although even at that time steel guns of large caliber were being made in Europe. For the next two decades the Government was content to use the heavy guns remaining from that conflict, merely inserting steel tubes in the muzzles to increase their resistance to internal pressure. It was not until 1883 that the Midvale Steel Works made the forgings for the first 6-inch breech-loading naval rifled guns purchased by the Federal Government. The solid tubes were bored at the Washington Navy Yard.[6] That year the Chief of Ordnance addressed a circular letter to the principal steel manufacturers of the United States, inquiring what facilities they possessed for manufacturing heavy guns and mortars for the coast defenses recently authorized by Congress. At this date forgings of the weight required could not be obtained in the United States, but it was the opinion of the Ordnance Department that large tire-rolling mills, by a moderate outlay for changing their present machinery, might produce the steel hoops used for banding the breeches of heavy ordnance. American steel makers had neither the plants nor the experience to produce steel forgings for the tube and jacket of a gun of 8-inch caliber, and these were ordered from England.[7]

In 1884 the Washington Navy Yard began the manufacture of heavy steel cannon to replace the iron and brass cannon still employed on some of our war vessels. By this time the Midvale Steel Works were able to make all the parts, including the tubes and jackets, of the 6-inch guns, but the tubes and jackets for 8-inch guns were still imported from Great Britain, "American appliances not being at present equal to the handling of such heavy steel forgings."[8] Even at this comparatively recent date the Government continued to give contracts for cast-iron cannon similar to those used twenty years before. In midsummer 1884 the explosion of 120 tons of molten iron in a mold 40 feet below the surfaces of the ground practically wrecked the casting house of the South Boston Iron Company, which was completing an order for five 12-inch guns of the old type. These cannon when finished weighed 54 tons.[9] By the close of the year, however, steel 32 pounders made entirely in this country were completed at the Watertown Arsenal, and the following year similar guns of 6-inch caliber were in commission. According to a popular description at that time

[6] American Iron and Steel Association, *Bulletin*, XVII, 3, Jan. 3 and 10, 1883.

[7] American Iron and Steel Association, *Bulletin*, XVII, 99, Apr. 11, 1883; XVII, 325, Nov. 21 and 28, 1883.

[8] American Iron and Steel Association, *Bulletin*, XVIII, 84, Mar. 26, 1884; XVIII, 138, May 28, 1884; XVIII, 149, June 4 and 11, 1884.

[9] American Iron and Steel Association, *Bulletin*, XVIII, 133, May 21, 1884; XVIII, 179, July 16, 1884; XIX, 5, Jan. 7, 1885.

these guns were said to "mark the highest point we have yet reached, not only in gun making but also in the art of forging large masses of steel."[10]

Notwithstanding this hopeful progress the Government still clung to the older types of ordnance, and only when iron was recognized to be definitely inferior to steel was recourse had to cast steel cannon. The South Boston Iron Works, which seem to have been the last establishment to make heavy cast-iron guns for the Government, turned out a 54-ton breech-loading rifled cannon of that material in 1886. This ended the history of that branch of founding at these works, and their heavy gun lathes were removed to Watervliet Arsenal the following year.[11] But in 1888 a 6-inch Bessemer steel gun was cast for the Government by the Pittsburgh Steel Casting Company, in the hope that artillery of this type would prove more successful as well as cheaper than the built-up steel guns recently constructed. The same company manufactured, also in 1888, the first cast-steel shells ever made in the United States. The steel gun was a failure, bursting under test; but the Government continued its experiments, ordering an even larger piece to be cast from open-hearth steel by the Standard Company near Chester. Neither of these guns was made by the Rodman process, both being bored from solid ingots. This second gun developed slight defects and had to be regaged, but it stood the statutory tests. Nevertheless it was not successful enough to encourage a continuation of experiments along that line.[12]

The forged guns of small caliber made from both iron and steel during the Civil War, therefore, represented the country's highest development in this branch of ordnance manufacture prior to the revival of interest in the Navy and in coast defenses soon after 1880. It will be recalled that during the Civil War heavy guns for the army and navy were supplied by private foundries at Boston, Providence, Chicopee, Cold Spring, New York, Phoenixville, Reading and Pittsburgh. The famous Fort Pitt foundry had now ceased to exist. The South Boston Iron Works, as just mentioned, ended their history as ordnance makers with the replacement of iron by steel. It was now decided to put the manufacture of highly specialized modern artillery directly in the hands of the Government, and under an Act of Congress of March 3, 1883, machinery for making heavy ordnance was installed at the Washington Navy Yard and at the Watervliet Arsenal, which was designed to provide large caliber guns for the army and for our coast defenses. But throughout the eighties both these establishments depended for heavy forgings upon foreign makers, especially the Schneider works at Creusot, France, and upon a few large establishments in America, notably the Midvale and the Bethlehem Works in eastern Pennsylvania,

[10] American Iron and Steel Association, *Bulletin*, XVIII, 173, July 2 and 9, 1884; XIX, 180, July 8, 1885.

[11] American Iron and Steel Association, *Bulletin*, XX, 93, Apr. 7, 1886; XXI, 194, July 20, 1887.

[12] American Iron and Steel Association, *Bulletin*, XXII, 21, Jan. 18, 1888; XXII, 61, Feb. 22, 1888; XXII, 245, Aug. 8, 1888; XXII, 370, Dec. 19, 1888; XXIII, 43, Feb. 13, 1889; XXIII, 107, Apr. 17 and 24, 1889.

and the Carnegie plants at Pittsburgh. The Carnegie Company made a practice, at least at one time, of subletting part of its contracts to independent mills in Pittsburgh and vicinity, but heavy work was for the most part done at its own establishments.[13]

In 1887 the General Manager of the Bethlehem Iron Company accompanied his bid for ordnance to the Navy Department by a letter in which he briefly reviewed the preparation made by his firm for supplying the needs of the Government. For more than a year the Company had been most diligently engaged constructing a complete forging plant, adapted to the fabrication of all the parts of the largest guns used by any nation on ships or vessels of any kind. It had contracted with the most successful ordnance and armor-plate makers of Europe for skilled superintendents, the use of patents and machinery; and it was preparing to build a hammer of the largest class. Upon these improvements the Company was expending or had expended $1,500,000. As a matter of fact, however, the Bethlehem Company never found it necessary to avail itself of all the foreign assistance here suggested. It brought no skilled workmen other than superintendents from abroad, nor did it receive any part of its machinery at this time from Creusot. Two years later, however, the press reported the arrival of 16 carloads of machinery from France for the ordnance department of the Bethlehem Works to be used in connection with Government contracts.[14]

By 1888 American plants were able to make all the parts of forged steel guns of 10-inch caliber; but the tube and jacket forgings for the first 12-inch steel gun manufactured in the United States, which was completed at the Watervliet Arsenal and tested in 1891, were purchased abroad at the Creusot works. The remaining forgings were made by the Midvale Steel Works. In publishing this fact, however, it was mentioned that American manufacturers were able at the time the gun was finally delivered to produce the largest forging required for ordnance use.[15] The following year the shops at the Washington Navy Yard were engaged upon a 13-inch gun of all American manufacture, and their machinery was capable of furnishing a 16-inch gun should that be required. By 1893 the Midvale Works were prepared to manufacture 13-inch guns. At this time the Washington Navy Yard, and the Bethlehem and the Midvale Works were among the most complete, if not the largest, establishments manufacturing heavy artillery in the world. The Bethlehem Works were using hydraulic presses in the manufacture of armor, though this was a novelty referred to as "a sort of secret process . . . which does away with the steam hammer, and which, it is said, is the only piece of machinery of this kind outside of Europe." The Bethlehem Company also erected a steam hammer of 125

[13] American Iron and Steel Association, *Bulletin*, XXIII, 211, Aug. 7, 1889.

[14] American Iron and Steel Association, *Bulletin*, XXI, 81, Mar. 30, 1887; XXI, 236, Aug. 31, 1887; XXIII, 93, Apr. 3, 1889.

[15] American Iron and Steel Association, *Bulletin*, XXII, 203, July 27, 1888; XXIII, 237, Aug. 28, 1889; XXV, 171, June 10, 1891.

tons, largely on account of the encouragement given by Government contracts.[16]

SHIPBUILDING

The manufacture of armor plates and heavy ordnance was due entirely to Government initiative and was in a sense a non-competitive branch of steel working so far as foreign rivalry was concerned. Though this was not equally true of the building of iron and steel vessels, the New Navy was constructed in American yards, and Government contracts were probably the decisive influence that upheld this industry in the period we are now discussing.

During the suspension of naval construction for nearly twenty years after the conclusion of the Civil War, only a few war sloops and revenue boats were built and some of the old monitors were kept in repair and remodeled. The Civil War vessels of this type had wooden hulls, which speedily rotted under their weight of armor. Even after the New Navy was well advanced we continued to build monitors, largely because sentiment and prejudice in Congress, and perhaps among our naval experts, caused this type of vessel to be favored after better types had been developed abroad. Their retention was due partly, however, to the theory that our Navy would be employed in time of war mainly in defending our ports and harbors, and the monitors were regarded as floating batteries, or extensions of coast fortifications, in which the Government and the nation were beginning to take serious interest.

Although what were called iron vessels had been built previously in America, iron shipbuilding dates as a continuous industry from about 1868, and during the era of low prices and industrial depression that followed the panic of 1873 competitive conditions, reinforced perhaps by the tradition of our earlier merchant marine, caused a notable though transient activity in this industry, especially along the Delaware. Congress had recently subsidized the Pacific Mail Company's transpacific lines, and some hope was entertained that this policy might be made permanent and extended to lines running to Spanish America and Europe. Our coasting trade was monopolized entirely under our flag. Vessels built abroad could not be registered in the American merchant marine, so that there was a residual market of coasting, river and lake steamers that American shipyards knew they would be called upon to supply. They also continued to do some work for the Navy.[17]

About 1872 John Roach established large iron shipbuilding and engine works near Chester, and the Cramp yards were in operation at Philadelphia. In 1873 four iron vessels were launched from the shipyard of Cramp and Sons for the American Steamship Company, which was the only American

[16] American Iron and Steel Association, *Bulletin*, XXIII, 3, Jan. 2 and 9, 1889; XXV, 91, Apr. 1, 1891; XXVI, 268, Sept. 14, 1892; XXVII, 27, Jan. 25, 1893.

[17] American Iron and Steel Association, *Bulletin*, VIII, 21, Jan. 15, 1874; *Engineering Magazine*, I, 376, 379, June 1891; Tenth Census, *Reports*, VIII (Shipbuilding), 197.

line maintaining a transatlantic passenger service. These were sister vessels, 355 feet long, with a burthen of a little more than 3,000 tons, affording accomodations for 75 first-class passengers and about 1,800 steerage and intermediate passengers, and providing more comfortable arrangements for the steerage than European competitors. There were other important and even longer established shipyards on the Delaware. That of Harlan and Hollingsworth at Wilmington, which built its first iron vessels as early as 1836, had a long list of launchings to its credit, though most of its steamers were of smaller tonnage than those just noted.

In 1872 the iron and shipbuilding industry was fully domesticated at Cleveland and Detroit. Iron vessels had been built experimentally on the Great Lakes and were afloat before that time; but the comparatively high price of iron, before the days of cheap steel, had restricted this type of construction. In 1874 a shipyard for building iron steamboats was established at St. Louis, which used plates rolled at the Laclede Mills in that city. At this time there were reported to be 15 firms in the United States that built iron vessels; 9 of these were on the Atlantic coast, 7 being on the Delaware; 3 were on the Great Lakes; and 3 were upon the Ohio and Mississippi. An eighth shipyard upon the Delaware went into operation at Bordentown early in 1874.[18] The latter year John Roach and Company launched twin steamers for the Pacific Mail Line, the *City of Peking* and the *City of Tokio*, which were rated the largest and in some respects the finest vessels then afloat. They exceeded slightly the tonnage of the Cunard Line's finest ship, the *Bothnia*, which was launched the same year on the Clyde. The dimensions of these two steamers were 423 feet over all, with a 48-foot beam, and a burthen of 5,000 and 5,500 tons respectively. Each steamer had accommodations for 150 cabin and 1,800 steerage passengers, and a speed of between 15 and 18 knots an hour. When the *City of Peking* was launched at Chester she was reported to be, with the single exception of the *Great Eastern*, the largest merchant vessel ever constructed. Her cost was about $1,000,000.[19] The same year the tiny steam yacht, *Aerolite*, 75 feet long, with a speed of 25 knots an hour, was launched at Philadelphia. She was the first all steel vessel built in the United States, and was intended for service in British waters.[20] In 1875 the Roach Works built three additional steamers of 3,500 tons burthen each for the Pacific Mail. The contract for these three vessels was obtained in competition with several English bidders, and the price agreed upon was as low as the lowest foreign tender. This year the Roach yards also shipped two iron steamers across the continent in sections, to ply upon San Francisco Harbor.[21]

[18] American Iron and Steel Association, *Report of Secretary for 1875*, p. 46; *id.*, *Bulletin*, IX, 37, Feb. 12, 1875; *Engineering Magazine*, I, 378-383; June 1891; IV, 833-834, Mar. 1893; Tenth Census, *Reports*, VIII (Shipbuilding), 203, 206–213.

[19] American Iron and Steel Association, *Bulletin*, VIII, 101, Mar. 26, 1874; VIII, 157, May 14, 1874.

[20] American Iron and Steel Association, *Bulletin*, VIII, 221, July 16, 1874.

[21] American Iron and Steel Association, *Bulletin*, IX, 114, Apr. 23, 1875; IX, 139, May 14, 1875; IX, 337, Nov. 12, 1875.

This brief period of activity came to an abrupt close by the Centennial year. Congress discontinued its subsidies and the American Line, started with such high hopes a few years before, was losing money. Nevertheless the latter part of that year the Atlantic Iron Works, near Norfolk, were purchased by northern capitalists who intended to inaugurate shipbuilding at that point. John Roach, in default of other orders, built two iron steamships on speculation.[22] In 1877 the Red Star Line, contemplating additions to its fleet, secured prices from both foreign and American makers for two large ocean steamers. The British bids were lower than those submitted on this side of the water, and the order went abroad. Yet the same year a Philadelphia firm secured contracts for three Amazon River iron steamers from Brazil, and three steamers for Cuba and South America. Two large vessels, 370 feet in length were built for a new Brazilian line this season, and the Cramps had under construction iron vessels for the Pacific coastal trade.[23] Since 1868, 251 iron steamers of all classes had been constructed in the United States. Two of these were of more than 5,000 tons burthen, and 8 were between 3,000 and 4,000 tons burthen. John Roach and Son claimed to have constructed more iron ships within five years than any single firm in Europe. Since 1872 this firm had built 33 steamers with an aggregate burthen of more than 68,000 tons, practically half of which was engaged in the foreign trade.[24]

Altogether, therefore, 1877 witnessed a considerable revival of activity in shipbuilding, particularly for the foreign service, and American builders were offering to construct iron vessels, according to report, at one pound sterling per ton less than was asked in England. This unexpected rivalry was due to a momentary depression of wages and prices in the United States, but it was regarded in Great Britain as an alarming symptom. American shipyards were equipped with more labor-saving machinery than those of their British competitors, and the cost of iron, copper and wood was, upon the whole, lower in America for the time being than abroad. John Roach offered to deliver iron sailing ships on the Clyde at prices that met those of the shipyards on that river. American coasting steamers, of which several were constructed this year, surpassed most transatlantic liners at that time in tonnage and accomodations.[25]

Shipbuilding was fairly active during 1878 when iron vessels to the value of about $5,000,000, with a burthen of 25,000 tons, were launched at the Delaware River yards. Philadelphia builders filled orders for the Russian Government, and John Roach and Son launched 9 vessels, the two largest with a registered burthen of more than 3,500 tons. That firm completed its sixty-fourth iron steamship this year and had under construction the

[22] American Iron and Steel Association, *Bulletin*, x, 221, Aug. 16, 1876; x, 338, Dec. 20, 1876.

[23] American Iron and Steel Association, *Bulletin*, xii, 19, Jan. 23 and 30, 1878; xii, 90, 94, Apr. 17 and 24, 1878.

[24] American Iron and Steel Association, *Bulletin*, xi, 123, May 2 and 9, 1877.

[25] American Iron and Steel Association, *Bulletin*, xi, 196, July 18 and 25, 1877; xi, 236, Sept. 5, 1877; xi, 261, Oct. 3, 1877.

monitor *Puritan.* Several of these vessels were for the South American and West Indies trade. In fact, Spanish American orders, or orders for vessels to be employed in Spanish American waters, accounted for no small share of the current activity.[26]

Testifying before a Congressional Committee in 1878, John Roach named four old shipbuilding firms at New York, which had been among the largest in the country at the close of the Civil War and had employed 15,000 men, whose works had been dismantled subsequently and their buildings converted to other uses.[27] During the interval the industry had concentrated on the Delaware, where his own yards at Chester had built 84,000 tons of steamships valued at over $16,000,000. Moreover, those vessels were equivalent in the carrying trade to a quarter of a million tons of sailing vessels. This year was in fact the most prosperous for iron shipbuilders, at least of any except 1874, although the largest steamer constructed in American yards that season had a burthen of only 3,548 tons. Maine shipbuilders did little more than half the normal amount of work in 1878, yet the total tonnage of wooden vessels built in the country was nearly 60 per cent greater than that of iron vessels. Ocean freights were abnormally low, and there was little incentive to add to deep-sea and coastal tonnage.[28]

The following season found Delaware shipyards well employed upon steamships for the lines plying along the southern coast and between New York, the West Indies and Brazil. Typical of these contracts was one for a vessel with a capacity of 4,500 bales of cotton for the Morgan Line. It was to operate in connection with the Louisiana and Texas Railroad, controlled by the same company. The Alexandre Line, plying between New York and southern ports, and the Dominion Line, were among other companies that extended their fleets this season. It was noted as an interesting fact that General Grant began his tour of the world on the *Indiana*, a transatlantic liner built at Philadelphia, and returned to this country on the *City of Tokio*, a transpacific liner built at Chester.[29]

In 1880 something of an innovation occurred when a three-masted iron schooner of 600 tons burthen was launched by Cramp and Sons at Philadelphia.[30] She was reported to be the first iron sailing vessel built on the Delaware, but this was an error, as such boats had been constructed at Wilmington before the Civil War. In the autumn a contract for the construction of two 3,000-ton colliers and six side-wheelers was placed at Philadelphia and Chester by the Oregon Improvement Company. These

[26] American Iron and Steel Association, *Bulletin*, XII, 172, July 24 and 31, 1878; XII, 187, Aug. 14, 1878; XIII, 13, Jan. 15 and 22, 1879.

[27] Tenth Census, *Reports*, VIII (Shipbuilding), 201–202; Brassey, *Lectures on the Labour Question*, 57.

[28] American Iron and Steel Association, *Bulletin*, XII, 209, Sept. 11, 1878; XII, 228, Oct. 2 and 9, 1878; XIII, 2, Jan. 8, 1879.

[29] American Iron and Steel Association, *Bulletin*, XIII, 94, Apr. 16, 1879; XIII, 101, Apr. 23, 1879; XIII, 110, Apr. 30, 1879; XIII, 182, July 16, 1879; XIII, 218, Sept. 3, 1879; XIII, 244, Sept. 24, 1879.

[30] American Iron and Steel Association, *Bulletin*, XIV, 105, May 5, 1880; Tenth Census, *Reports*, VIII (Shipbuilding), 204–205.

boats, which were built of iron, were designed to navigate to their destination, and eventually to ply upon the Columbia River and along the Oregon coast.[31]

What is described as a boom occurred on the Delaware in 1881. Several boats were launched for the Iron Steamboat Company, operating between New York and Coney Island, and a number of larger vessels were built for coastal trade. In fact Cramp's shipyards were obliged to refuse orders for two steamers for lack of room.[32] This season was also marked by great activity in the shipyards along the Great Lakes. The Detroit Drydock Company, established in 1872, was building iron vessels at Wyandotte and wooden vessels at an extensive yard in Detroit itself. With the completion of the steamers on the ways, the Wyandotte yards would have turned out 16 iron vessels. Wooden steamboats continued to be built, and what were called four-master schooner-rigged "consorts" were also under construction to be employed in the Lake Superior ore trade. Four of these vessels were towed by a steamboat of about the same dimensions. This year a new iron shipyard was established at Cleveland, and in that city an iron ore boat, reported to be the largest on the Lake, was launched. Her length was slightly over 300 feet and her capacity 3,200 tons.[33] Iron steamers also continued to be built on the Mississippi and at Pittsburgh, and the first iron steamship ever built on the Pacific was begun this year. Simultaneously better times dawned for the wooden shipbuilders of Maine.[34]

During the following season most of the shipyards on the Delaware were well occupied, with orders for 35,000 or 40,000 tons of iron vessels on their books. In May a steamer built for the Lehigh Valley Railroad at the Globe Works in Cleveland arrived at Chicago with 2,700 tons of coal, the largest cargo ever brought into that port. This is probably the steamer mentioned as under construction the previous year. A Pittsburgh builder completed a river steamer entirely of steel, said to be the first river boat built in this country in which no iron whatever was used. She took a cargo to New Orleans, then passing through the Gulf and the Florida Channel finally reached her destination at Columbus, Georgia, via the Atlantic and the Chattahoochee River. This season was an unusually active one for wooden shipbuilders on the Pacific Coast, 22 new vessels of over 5,000 tons aggregate measurement being launched at various Pacific yards. In addition to lumber schooners and other coastal vessels, they included three steam whalers and also vessels intended for the Hawaiian trade, which was reported to have "given a great stimulus to this industry." Two small

[31] American Iron and Steel Association, *Bulletin*, XIV, 284, Nov. 17 and 24, 1880.

[32] American Iron and Steel Association, *Bulletin*, XV, 33, Feb. 9, 1881; XV, 77, Mar. 23 and 30, 1881; XV, 148, June 15, 1881.

[33] American Iron and Steel Association, *Bulletin*, XV, 83, Apr. 6, 1881; XV, 123, May 18, 1881; XV, 257, Oct. 12, 1881; Catlin, *The Story of Detroit*, 498; Tenth Census, *Reports*, VIII (Shipbuilding), 221; *cf. ibid.*, 208.

[34] American Iron and Steel Association, *Bulletin*, XV, 83, Apr. 6, 1881; XV, 177, July 20, 1881; XV, 177, July 20, 1881.

iron steamers were built at San Francisco in 1881, one of which, of only 30 tons burthen, was for parties in Ecuador, whither she made her way safely under her own power.[35]

In 1883 the shipyards completed by the Philadelphia and Reading Railroad Company at the former city, just previous to that Company's passing into the hands of receivers, were leased to a new shipbuilding firm, which began launching vessels the following season. This year the Navy Department awarded contracts for three cruisers of the New Navy, the *Chicago*, the *Atlanta* and the *Boston*, and for the despatch boat, *Dolphin*, to John Roach and Son, who were the lowest bidders. The aggregate cost of these four vessels was just under $2,500,000. Early in August this firm launched its one-hundredth vessel. Forty-thousand tons of iron and steel shipping had been built upon the Delaware in 1882, and the contracts foi 1883 including the cruisers for the Navy called for a much larger amount. Among the commercial vessels were three sister boats for the Brazil trade, one for Cuba, and one for Alaska. South America was still rated among the best customers of the Delaware shipbuilders. John Roach attributed his success in capturing Navy contracts partly to the fact that he was the only shipbuilder who had a steel plant in his own yard. When the bids were opened one of his competitors, Mr. Cramp, explained that the steel makers from whom he got bids asked him three cents a pound more than the Roach tender. Although a large amount of shipping was contracted for and under construction, only 36,646 tons of iron merchant vessels were actually launched. All but four of these vessels were built on the Delaware.[36]

Preparations for building iron and steel vessels of larger dimensions than had hitherto been launched on the Pacific Coast were made at San Francisco in 1884, with the construction of the plant of the Union Iron Works. Shipyards were also projected at Alexandria, Virginia, in response to considerations that resulted in the later location of this industry at Newport News. The first steel vessel ever built on the Great Lakes was launched at Wyandotte, Michigan. She had a carrying capacity of 2,500 tons. Shipyards on the Delaware were only moderately busy and builders were somewhat depressed by the sale of the four steamers of the American Line, which had been backed by the Pennsylvania Railroad Company, to British owners, thus removing the American flag from the transatlantic trade.[37]

An unhappy controversy between John Roach, who had been for some years the most prominent iron shipbuilder in the United States, and the Washington Government over accepting the vessels for the New Navy for which he had bid successfullly two years previously, led to the insolvency

[35] American Iron and Steel Association, *Bulletin*, XVI, 51, Feb. 15, 1882; XVI, 122, May 3, 1882; XVI, 125, May 3, 1882; XVI, 141, May 17 and 24, 1882; XVI, 337, Dec. 20, 1882.

[36] American Iron and Steel Association, *Bulletin*, XVII, 58, Feb. 28, 1883; XVII, 107, Apr. 18 and 25, 1883; XVII, 187, July 11, 1883; XVII, 209, Aug. 8, 1883; XVII, 249, Sept. 12, 1883; XVII, 306, Nov. 7, 1883; XVIII, 28, Jan. 23 and 30, 1884.

[37] American Iron and Steel Association, *Bulletin*, XVII, 69, Mar. 12, 1884; XVIII, 106, Apr. 23 and 30, 1884; XVIII, 221, Aug. 27, 1884; XVIII, 275, Oct. 29, 1884.

of his firm. The new cruisers, which were built from Navy plans and specifications, did not fulfill expectations. Whether this was due to the inability of American shipbuilders to meet the requirements of the Department or to the fault of the Department's plans, or to both, was never clearly settled. One result of this incident, that proved helpful ultimately to the shipbuilding industry, was the demonstrated inexpediency of giving all Navy contracts to the lowest bidder. Thereafter contracts were distributed to different firms, much to the advantage both of the Government and the industry.[38] In 1885 the Cramp yards launched the steam yacht *Peerless*, containing the first successful triple expansion steam engine ever built in this country. Engines of this type were not introduced in Naval vessels until four years later. The first steel steamship ever built at San Francisco, a small collier of 750 tons designed for service in Oregon, was launched in 1885 by the Union Iron Works. Its plates were rolled in the East, but the keel, stern and stem frames and angle work were forged in San Francisco.[39] About this time wooden vessels of record size were built in Maine and a sailing ship of over 2,600 tons net register was launched at Camden. She was nearly a thousand tons smaller, however, than the *Great Republic*, launched in Boston in 1853, which was the largest sailing vessel of American register that saw service until nearly forty years later. A second vessel, the first four-masted ship ever built in America, also exceeding 2,600 tons burthen, was launched at Rockland the same year. An interesting feature of these vessels, that continued to characterize the products of Maine shipyards, was that the timber from which they were constructed came from some of the remotest parts of the continent. Their masts were Oregon pine, their planking Southern pine and their frame Virginia oak.[40]

During 1886 the Cramp yards at Philadelphia were very busy, mainly upon vessels for the coasting trade and for lines operating between New York and Brazil. John Roach and Son, having reorganized, received contracts for two new merchant steamers, which were also to run to South America. Simultaneously a notable expansion of shipbuilding began on the Great Lakes. Vessels rapidly increased in size and new shipyards with the most modern equipment were established at several points. In 1886 the Union Drydock Company at Buffalo launched a steel steamer of 3,000 tons burthen, said to be the largest on these waters. The transportation of petroleum in tankers began to receive serious attention, although the first vessels engaged in this trade were quite different in construction and arrangement from the typical tanker of today. Steel had rapidly displaced iron for building ships during the preceding decade. Previous to 1875 steel

[38] American Iron and Steel Association, *Bulletin*, XIX, 218, 221, Aug. 19, 1885; XIX, 283, Oct. 21 and 28, 1885; XIX, 289, Nov. 4, 1885.

[39] American Iron and Steel Association, *Bulletin*, XIX, 93, Apr. 8, 1885; XXII, 281, Sept. 19, 1888; *Engineering Magazine*, I, 383, June 1891; I, 426, July 1891.

[40] American Iron and Steel Association, *Bulletin*, XIX, 162, June 24, 1885; XIX, 259, Sept. 30, 1885.

was so variable in quality that angle bars might be very ductile at one extremity and extremely brittle at the other; some plates and bars from a batch would be soft and ductile, and others from the same batch would possess many characteristics of tool steel; and after a plate was riveted in place it would not infrequently fracture without warning. By the middle of the eighties most of these uncertainties had been so far overcome that many all-steel vessels were being built in private yards.[41]

Palatial river and coastal steamers, according to the standards of the time, had always been a specialty with American builders. This tradition was continued when the Roach Yards, which were managed by the sons after their father's death, launched what were reported to be the two largest steamboats afloat, the *Pilgrim* and the *Puritan*, for what is now the Fall River Line. The *Pilgrim* was built in 1882, the *Puritan* in 1887 and 1888. The latter steamer, which was 420 feet long, exceeded the dimensions of most ocean liners of the period, although she naturally varied from them in design. This year the Roach shipyards also launched what was said to be the first iron tanker to sail under the American flag.[42] Several gunboats were built by John Roach's sons, and Cramp and Sons built two large cruisers for the Government. With the establishment of the Union Iron Works at San Francisco, Naval contracts began to be placed on the Pacific Coast, and this year the steel cruiser *Charlestown* was under construction there. From this date onward Naval contracts continued to contribute an important share to the business of American shipyards.[43] On the Great Lakes the demand for additional tonnage, especially for carrying iron ore, was very active. During 1887, 5 steel steamers and 44 wooden steamers were built there, in addition to 4 wooden sailing vessels. Wooden steamers cost only $10 per ton less than steel steamers, yet the tonnage of new wooden steamers was more than four-fold that of new iron steamers, a condition that was to be reversed within the next few years.[44]

In 1888 Cramp and Sons built for the Clyde Line what was reported to be the first all-steel steamship constructed in America for the ocean carrying trade, and the largest steamer in the coastal service. All of the steel except the propeller shafts entering into the Naval vessels built by this firm was of American manufacture. Between 1868 and 1888 inclusive, over half a million tons of iron and steel vessels had been built in the United States, and hitherto nearly all of those designed for salt-water traffic had been constructed on the Delaware. The Union Iron Works at San Francisco were engaged principally on contracts for the Navy although they launched some small vessels for local service. In 1889 the Maryland Steel Company

[41] American Iron and Steel Association, *Bulletin*, xx, 205, Aug. 4, 1886; xx, 237, Sept. 8, 1886; xx, 242, Sept. 15, 1886; xx, 258, Sept. 29, 1886; xx, 269, Oct. 6 and 13, 1886.

[42] American Iron and Steel Association, *Bulletin*, xxi, 221, Aug. 17, 1887; xxi, 322, Nov. 23, 1887; xxii, 237, Aug. 1, 1888.

[43] American Iron and Steel Association, *Bulletin*, xxi, 117, May 4, 1887; xxi, 227, Aug. 24, 1887.

[44] American Iron and Steel Association, *Bulletin*, xxi, 349, Dec. 21, 1887.

began the construction at Sparrows Point of what was to become one of the leading shipyards in the United States. The Columbian Iron Works and Drydock Company, also of Baltimore, was at that time building two cruisers for the Government.[45]

The most notable incident of the year on the Great Lakes was the entrance of the Illinois Steel Company into the shipbuilding business through an arrangement with the Globe Iron Works of Cleveland. Large shipyards were projected at Chicago and were already receiving contracts for vessels. We thus see at both Sparrows Point and Chicago large steel corporations entering a steel-consuming industry. This year, also, the first whalebacks were launched at Duluth. Their low free-board was designed to offer a minimum resistance to the wind and thus to lessen the danger of their breaking loose from tows during storms. The first boats of this type had a carrying capacity of about 3,000 tons. Large wooden ships, mostly four-masters, continued to leave the ways of the Maine shipyards, two of those launched this year being of 3,000-tons capacity. A four-master schooner of 1,600 tons and several sister vessels of the same type almost rivaling her in size were also built the same year at various points in Maine.[46]

It was not until 1890 that construction began on the first battleships built by the United States. Contracts for two of these were awarded to Cramp and Sons of Philadelphia, and for the third to the Union Iron Works at San Francisco. By this time the New Navy, including vessels still on the ways, consisted of 15 armored and 31 unarmored ships, all of which were built or building in the United States. Cramp and Sons increased their capitalization and purchased an additional site to enlarge their yard. The shipyard at Sparrows Point was under construction, and preparations were being made to lay down the keels for two 3,000-tons steamers to be used in the Maryland Steel Company's ore trade. This year a wooden vessel of over 3,400 tons burthen was launched at Bath, the first four-masted ship ever built at that town.[47] This was also an unusually active season at Great Lake shipyards. Within four years the tonnage on the Lakes had increased by over 141,000 tons, which represented an investment in new vessels during that period of more than $27,000,000. The Chicago Shipbuilding Company was now in operation, and two steel vessels of 3,500 tons capacity were under construction at Bay City, Michigan, for service on the Atlantic. They were to be taken through the Welland Canal in sections, and were built on the Great Lakes, not because lower bids were received from interior shipyards, but because the Delaware yards were so

[45] American Iron and Steel Association, *Bulletin*, XXII, 45, Feb. 6, 1888; XXII, 213, July 4, 1888; XXII, 298, Oct. 3 and 10, 1888; XXIII, 109, Apr. 17 and 24, 1889; *Manufacturers' Record*, XVI, 11, Nov. 2, 1889.

[46] American Iron and Steel Association, *Bulletin*, XXIII, 209, Aug. 7, 1889; XXIII, 219, Aug. 14, 1889; XXIII, 236, Aug. 28, 1889; XXIII, 250, Sept. 11, 1889; XXIII, 356, Dec. 25, 1889.

[47] American Iron and Steel Association, *Bulletin*, XXIV, 51, 53, Feb. 19 and 26, 1890; XXIV, 165, June 11, 1890; XXIV, 293, Oct. 15, 1890; XXIV, 349, Dec. 3, 1890; *Engineering Magazine*, I, 436–438, July 1891.

crowded with work that they could not accept additional commissions. A 3,500-ton ore boat was in course of construction at Toledo. Between 1880 and 1890 the capacity of the iron and steel vessels built in the United States rose from 31,000 tons to 124,000 tons, while that of wooden vessels fell from 401,000 tons to 320,000 tons.[48]

The shipbuilding industry on the Atlantic Coast took an important step southward in 1891, when the Newport News Shipyard and Drydock Company, promoted by Collis P. Huntington, began to launch vessels. This yard, which cost $3,000,000, was one of the most complete in the world. Its earliest contracts included three 4,000-tons steamers for the Morgan Line. The same year the Cramp Shipyards at Philadelphia bought the old Port Richmond Iron Works and added them to their establishment. They also developed a new yard farther down the Delaware, extensive enough to build simultaneously seven vessels as large as the cruiser *Philadelphia*. This year the Union Iron Works received from the Pacific Mail Company their first contract for an important ocean liner, a 4,000-tons steamer to be employed on the China route.[49] Each year witnessed an increase in the size of the vessels launched on the Great Lakes. A passenger steamboat, 450 feet long, to run between Duluth and Buffalo, was under construction at the latter city, where new yards with a capacity to turn out a completed vessel every sixty days, had recently gone into operation. Over 50,000 tons of shipping to be employed in Lake commerce were under contract with this single Company. Though a shrinkage of output as well as prices occurred in most branches of iron and steel manufacturing, the tonnage of iron and steel vessels built during the fiscal year ending June 30, 1891, rose to a new record. Including vessels launched on the seaboard and the Great Lakes, the total addition to our merchant fleet was 105,618 tons, or more than 25,000 tons above the record year of 1890.[50]

Shipbuilding on the Delaware was active in 1892, partly perhaps as a result of the new subsidy act. An iron steamer for the Pacific Mail Company was launched at Chester, and contracts were let to William Cramp and Sons for five steamers, to cost in the aggregate nearly $9,000,000, for the International Navigation Company. The Sparrows Point Yards launched a steel steamship this year, and began extending their plant to accomodate eight steamers of the first magnitude at one time. The Newport News Company inaugurated steel shipbuilding south of the Potomac by completing the three vessels, of approximately 4,000-tons register each, which were on its ways for the Morgan Line. The largest ship hitherto launched in the United States was the cruiser *New York*, built by the Cramps

[48] American Iron and Steel Association, *Bulletin*, XXIV, 5, Jan. 1 and 8, 1890; XXIV, 51, Feb. 19 and 26, 1890; XXIV, 83, Mar. 26, 1890; XXIV, 141, May 21, 1890; XXIV, 205, July 16, 1890; XXIV, 243, Aug. 27, 1890; Eleventh Census, *Report on Manufactures, Selected Industries*, 552.

[49] American Iron and Steel Association, *Bulletin*, XXV, 93, Apr. 1, 1891; XXV, 229, Aug. 5, 1891; XXV, 289, Oct. 7, 1891; *Commercial and Financial Chronicle*, LIII, 716-717, Nov. 14, 1891; *Manufacturers' Record*, XVIII, 38, Jan. 10, 1891; *Engineering Magazine*, I, 654-655, Aug. 1891.

[50] American Iron and Steel Association, *Bulletin*, XXV, 77, Mar. 18, 1891; XXV, 149, May 20, 1891; XXV, 289, Oct. 7, 1891; XXVI, 133, May 11, 1892.

at Philadelphia. When all the vessels under contract at that time were completed, the New Navy would have 40 modern ships, and so confident were the builders that the art of naval construction had reached its highest point in these vessels, that Cramps' manager optimistically predicted:

"We have now reached the maximum development in steam and steel, and I look for no change for a generation at least. A ship of any class thoroughly effective in 1892 will continue to be so for fifty years if it lasts."

The Union Iron Works at San Francisco were building a cruiser of 5,800 tons. Smaller vessels were launched in New Jersey and at Bath, Maine, where the change from wood to steel began this year.[51]

Upon the Great Lakes also shipbuilders were busy and prosperous, becaused the ore and grain trade called constantly for new tonnage. Among the vessels launched at Detroit was one designed especially for carrying charcoal iron from the upper Michigan furnaces to Eastern markets. The Globe Iron Works, at Cleveland, completed what was reported to be the largest steamer on fresh water, with a capacity of 3,600 tons. The same year two whalebacks were launched at West Superior, each of which was designed to carry 2,800 tons of flour. But cargo boats were not the only vessels under construction at this time. A new steel passenger steamer built at Chicago had accomodations for 400 passengers, as well as 1,500 tons of freight. The following year, which was destined to witness a sudden reversal of the prosperous business conditions that had prevailed for several years, opened with the launching at Bay City, Michigan, of a steel steamer nearly 380 feet in length, with a carrying capacity of 4,000 tons. This was the largest boat built for fresh-water service during this period.[52] By its close, however, thanks largely to the highly standardized traffic handled by our Great Lakes tonnage, the average size of the vessels registered in those waters was double that of the vessels of our ocean-going merchant marine.[53]

[51] American Iron and Steel Association, *Bulletin*, xxvi, 61, Mar. 2, 1892; xxvi, 85, Mar. 23 and 30, 1892; xxvi, 114, Apr. 27, 1892; xxvi, 125, May 4, 1892; xxvi, 137, May 18, 1892; xxvi, 173, June 15, 1892; xxvi, 293, Oct. 5, 1892; xxvi, 301, Oct. 12, 1892; xxvi, 331, Nov. 9 and 16, 1892.

[52] American Iron and Steel Association, *Bulletin*, xxvi, 147, May 25, 1892; xxvi, 181, June 22, 1892; xxvi, 189, June 29, 1892; xxvi, 197, July 6, 1892; xxvi, 293, Oct. 5, 1892; xxvii, 141, May 10, 1893.

[53] *Engineering Magazine*, iv, 827, Mar. 1893.

CHAPTER XXVIII

RAILS AND ROLLING STOCK

TRANSITION FROM IRON TO STEEL

When the panic of 1873 abruptly halted railway construction the effect was immediately felt by the rail mills of the country. Early in 1874 the Western Rail Association, comprising some 31 mills in Pittsburgh and west of that city engaged in rolling iron rails, attempted to take concerted measures to relieve the situation, though there is no record that definite proposals were agreed upon for this purpose. Indeed, it is difficult to see what remedy could have been adopted, for practically all these mills were idle. Eight companies were manufacturing steel rails at this time, while there were 49 mills making heavy iron rails; 22 of the latter establishments were closed throughout the year and several of the remainder worked only part time, although the steel rail business, while not booming, continued to expand. The consumption of rails of all kinds during this year was about half what it had been in 1872; but the decline in domestic production was somewhat less than these figures would suggest, because of the heavy decrease in importations to a little over 100,000 tons from more than half a million tons two years before. That year the American Society of Civil Engineers appointed a committee to investigate and report upon the form, weight, manufacture and life of rails. In the report of this committee, made two years later, emphasis was laid upon the deterioration in quality of the iron rails made during the boom of the early seventies, which helped to explain the rapid adoption of steel rails in their place.[1]

By 1875 the business depression and the rapid decline in the cost of domestic rails practically stopped importations, and during the first quarter of the year not a foreign rail was landed at New York. The Southern Pacific Company of California, which received its rails by sea, contracted this year for 15,000 tons from the Pennsylvania Steel Company and the Bethlehem Iron Company to be delivered around the Horn. The price of domestic rails had fallen 40 per cent since 1873, and was reported to be in the West 25 per cent less than the cost of foreign rails. The substitution of steel for iron raised the question of what should be done with the iron

[1]American Iron and Steel Association, *Bulletin*, VIII, 121, 125, Apr. 16, 1874; IX, 267, Sept. 3, 1875; *Iron Age*, XCIII, 1014–1015, Apr. 23, 1914.

rails being replaced and with steel rails when they wore out; in fact the transition from iron to steel was conditioned in many instances by the ability of a railway to secure a reasonable price for the iron rails previously in use. Steel rails had been in use so short a time that few old ones were entering the market through replacements; but when they did so they could not be re-rolled like iron rails. Purchasers were reassured by the prediction of steel men that when the supply of old steel rails was larger uses would be found for them in the manufacture of tires and agricultural implements. It was also suggested as early as 1875 that a market for old iron rails might be found in the manufacture of open-hearth steel.[2]

In 1876 public attention was attracted to the fact that while the total output of rails rolled in the United States fell from approximately a million tons in 1872 to less than three-quarters that amount in 1874, and had increased but slightly since the latter year, the output of Bessemer rails was steadily rising. It was 94,000 tons in 1874 and 291,000 tons in 1875. The former year the ratio of steel rails to the total output was 9.4 per cent; the latter year it was 36.7 per cent. This was a remarkable record in view of the decline in railway construction and the great economies that railway managers were forced to make. But iron rails were not displaced without a struggle, and for some years after this the relative economy of iron and steel continued to be debated. The Reading Railroad Company perfected a process of reheating and hardening iron rails, which it was claimed at the time made them as durable as those of steel; and on some Western lines they stood the test of heavy traffic for thirteen years. The Milwaukee Iron Company adopted the Reading process with satisfactory results.

In practice, however, railway companies were laying steel wherever their traffic was heavy, transferring serviceable iron rails to sidings, branches and light traffic divisions, and purchasing iron rails, which were cheaper, for replacements where traffic did not demand the more expensive steel. Consequently mills rolling iron rails exclusively continued to be fairly well employed in normal seasons, and the rate of displacement of iron was considerably slower than it otherwise would have been.[3] The effect of the more extensive use of steel was disclosed chiefly in decreased renewals. In 1872 over 14 tons of rails per mile in operation were required upon an average for replacements; in 1876 this figure had fallen to 9 tons, a decrease of over 37 per cent within 5 years. Partly, it is true, this was due to the great economy exercised by railway managers in making renewals, but notwithstanding this the superior durability of steel was clearly manifest. In 1877 for the first time, the quantity of Bessemer steel rails made in the country exceeded the quantity of iron rails, reaching 432,000 tons, as compared with 332,000 tons of the latter. By far the larger part of the steel rails

[2] American Iron and Steel Association, *Bulletin*, IX, 108, Apr. 16, 1875; IX, 157, May 28, 1875; IX, 297, Oct. 8, 1875.

[3] American Iron and Steel Association, *Bulletin*, X, 169, June 14 and 21, 1876; X, 179, June 28, 1876; X, 193, 194, 196, July 19, 1876.

laid down went into replacements, most new roads being laid with iron. Since the steel was almost without exception on tracks having the heaviest traffic, the total railway haulage of the country over steel roadbeds was probably as great as that over all the iron tracks combined, although the mileage of iron track was still five times that of steel.[4]

Low prices in 1877 induced steel men to attempt to combine for the purpose of steadying the market; but this project proved unsuccessful. Production had outrun consumption not only because new railway construction had fallen off, but also because mechanical improvements and the increasing skill and efficiency of labor enabled works to turn out a much larger output than was foreseen when they were erected. Plants designed to make 15,000 to 20,000 tons a year actually produced, according to contemporary statements, as much as 50,000 tons. As a result of these combined influences the price of steel rails fell from $120 a ton in 1873 to $40 a ton four years later.[5] This brought the price of iron and steel rails close together; in fact the difference in their cost in 1873 exceeded the price of steel rails four years later. It was well understood that by running to full capacity, production costs were materially reduced, and therefore cash buyers were quoted very low rates in an effort to keep works up to their maximum output. It was the cheapness of steel rails during the late seventies that crowded iron rails out of the market so rapidly; because steel rails at $40 or $45 a ton were unquestionably a better investment for almost any road than iron rails at $30 or $35 a ton, the minimum price at which they could be profitably manufactured. Furthermore, these low prices not only helped to encourage new railway construction, but they made this a desirable time for making replacements, neglected during the lean years that had preceded.

A lively controversy arose in 1879 over an order for 12,000 tons of steel rails given to English manufacturers by the New York Central Railroad Company, at prices, including duty, considerably higher than were asked by American manufacturers. The English rails cost five pounds sterling a ton, plus $28 duty, or about $53 a ton delivered at a time when American Bessemer steel rails could be bought at from $43 to $47 a ton. But British makers in special cases gave a guaranty of twelve years, replacing all rails not reaching that standard of endurance free of cost, while the customary American guaranty, borrowed from the one originally given by English firms, was for only five years, and this was the "utmost limit of wear" for such rails as were manufactured at that time. Therefore the more expensive English rails were cheaper on lines having exceptionally heavy traffic, like certain divisions of the New York Central. That Company, however, was buying American steel rails, just as Western companies bought iron rails, for sidings and divisions having light traffic. Iron rails were also imported from Great Britain this year, because the duty upon them was

[4] American Iron and Steel Association, *Bulletin*, XXI, 237, Sept. 5, 1877.

[5] American Iron and Steel Association, *Bulletin*, XI, 289, Nov. 7, 1877; XII, 6, Jan. 2 and 9, 1878.

only about 60 per cent of the duty upon steel rails. Since the prices of iron and steel were about equal in Great Britain at this time, iron rails could be exported to the United States at a considerable profit, inasmuch as the difference in their price and that of steel rails in America was less than the difference in duty.[6]

Open-hearth steel rails, which were more commonly used in Europe than in the United States, first appeared in American statistics of production in 1878. They were rolled in America to some extent from imported blooms.[7] The output of iron rails increased in 1878–79, after declining steadily since the beginning of the decade, because with the revival of railroad construction the steel works were unable for a time to supply requirements and prices rose so high that iron rails again became profitable at a price sufficiently below the price of steel to tempt buyers for light traffic lines. By the end of 1879 the margin between the two was $17 a ton, and during that year 439,000 tons of iron rails and 718,000 tons of steel rails were rolled in this country. In 1880 the production of steel rails surpassed any previous year, exceeding that of 1879 by 31 per cent; indeed the output of both iron and steel rails increased, though the addition to the Bessemer output was 40 per cent, while that to the iron output was only 18 per cent.[8]

LOW PRICES AND TRADE AGREEMENTS

Rail making continued to move westward, toward districts of active railway development, although Pennsylvania still rolled more than half the rails manufactured in the country. Many technical improvements were made about this time. At the South Chicago Works rails were rolled in 90-foot lengths and cut to the ordinary 30-foot dimensions, avoiding waste and the expense of double handling and reheating.[9] More than 22,000 tons of street rails were made in the United States in 1882, of which about half were iron. The slower progress of steel in this branch of the industry was due partly to lighter wear and partly to the fact that street rails were often rolled by local works in the cities where they were used.[10]

The season of 1883 opened an era of still lower prices, with rails below $40 a ton and large works making record outputs in an effort to cheapen production. By autumn the price had fallen to $37 a ton, a radical decline from the $80 a ton that they had cost in February three years before. During the following winter contracts for $35 were made and the Pennsylvania companies entered the Chicago field, where there was a short period of brisk competition between eastern and local makers. The decline in rail output which now set in was not peculiar to the United States. Many

[6] American Iron and Steel Association, *Bulletin*, XIII, 93, Apr. 16, 1879; XIII, 253, Oct. 1 and 8, 1879; *The Duty on Steel Rails*, 33–37.

[7] W. D. Nixon in *De Bow's Review*, New Series, I, 43–44, Oct. 1879.

[8] American Iron and Steel Association, *Bulletin*, XIV, 154, June 23 and 30, 1880; XV, 116, May 4 and 11, 1881.

[9] American Iron and Steel Association, *Bulletin*, XVI, 203, July 26, 1882.

[10] American Iron and Steel Association, *Bulletin*, XVII, 149, May 30, 1883.

British and European works also curtailed production.[11] Prices sank even lower in 1884, reaching $26.50 a ton in Pennsylvania. The Lackawanna Iron and Steel Company underbid several English manufacturers and secured a contract to deliver 10,000 tons of steel rails to the Canadian Pacific Company at $28.50 a ton. This was the first important sale of steel rails ever made by an American manufacturer in foreign markets, though small quantities had been exported to Cuba and South America. The Lackawanna contract was considerably more than twice as large as the total exports of rails during the two years preceding; and, indeed, we had imported 113,000 tons of steel rails during the twelve months ending with June 1883. This turning of the tables upon British makers caused some irritation in Great Britain, and American works were accused in that country of conducting their affairs in an unbusinesslike manner, "filling their order books without much, if any, reference to the relation between cost and selling price in their cut-throat competition with each other."[12]

Though these charges were promptly denied with some citation of evidence, unhealthy competition existed at this time. In August 1885, the leading companies of the country, including those as far west as Chicago and Joliet, met at Long Branch and entered into an agreement to curtail their production and to pro rate their orders. It was alleged that no price agreements were made, although informal understandings may have existed. This first meeting decided to limit production for the coming year to 775,000 tons, a figure soon raised in view of increasing demands, and to allot this output in a pre-determined ratio to the different parties to the agreement. A few months later the figure thus stipulated was raised to 1,000,000 tons. The Vulcan Works at St. Louis started their rail mill about this time, claiming to be the only establishment "outside of the existing combination whose purposes are the limitation of output." This association or pool remained in existence until 1897 or for twelve years, and its object was ultimately extended to include the regulation of prices. As we shall see later, it was dissolved as the result of internal dissensions.[13]

The total capacity of the mills in the Association at this time was about a million and a half tons a year. Although the market improved somewhat in 1885 and 1886 there was little prospect of a return of the high prices of a few years before.[14] An International Steel Rail Association, composed of British, German and Belgian manufacturers, dissolved about this time, and in Europe rails dropped to the neighborhood of $18 a ton, which made it possible to deliver them in the United States with duty paid at a little

[11] American Iron and Steel Association, *Bulletin*, XVII, 285, Oct. 10, 1883; XVII, 309, Nov. 7, 1883; XVII, 332, Dec. 5, 1883; XVIII, 60, Mar. 5, 1884.

[12] American Iron and Steel Association, *Bulletin*, XVIII, 268, Oct. 15 and 22, 1884; XVIII, 285, Nov. 5, 1884; XVIII, 313, Dec. 3 and 10, 1884; XIX, 61, Mar. 4, 1885; XIX, 68, Mar. 11, 1885.

[13] American Iron and Steel Association, *Bulletin*, XIX, 220, Aug. 19, 1885; XIX, 225, Aug. 26, 1885; XIX, 333, Dec. 16, 1885; XIX, 349, Dec. 30, 1885.

[14] American Iron and Steel Association, *Bulletin*, XX, 220, Aug. 18 and 25, 1886; XXII, 36, Feb. 1, 1888; XXII, 43, Feb. 8, 1888.

over $37. Foreign rails were shipped to our southern ports as ballast in steamers coming for cotton cargoes, and usually entered the country at this point or on the Pacific Coast.[15] Prices in America were, it was claimed, below the cost of production. Both the Bethlehem Iron Company and the Cambria Iron Company testified before the Ways and Means Committee at Washington that they had lost money on their rail business in 1885. On the other hand, conditions were promising enough to encourage the Roane Iron Works, at Chattanooga, to erect steel furnaces for the purpose of making rails, and heavy orders came in during the summer from the Northwest. Those reported in a single issue of the *Bulletin* of the American Iron and Steel Association in August of this year, as given by lines entering Minnesota, aggregated 81,000 tons.[16]

PLANT OUTPUTS AND HEAVIER RAIL SECTIONS

This was a period when new rail mills with improved machinery emulated each other in making records, which suggested a contemporary review of the progress of rail making and railway methods since the introduction of steel rails eighteen years before. When the first Bessemer rails were made in this country they were manufactured at the rate of 300 a day and sold for $125 a ton. In 1886 the best works made 3,000 rails a day and the price was below $30 a ton. Meanwhile, the amount of phosphorus permitted in standard Bessemer ores had declined from between 0.1 and 0.2 per cent in 1870, to 0.08 per cent; and the proportion of manganese in the spiegeleisen had been raised from 10 per cent to as high as 45 per cent. As a result the quality of American steel had greatly improved, while the method of manufacturing rails in a single heat had added to their quality irrespective of the materials from which they were made. While locomotives had quadrupled in weight, from 15 to 60 tons, cars had more than doubled in capacity, from 10 to 20 and 25 tons, and the maximum speed of freight trains had risen from 15 to 25 and 30 miles an hour, the same weight of rail was used as twelve years before. This was cited to show the improvement in the quality of rails during that period.[17] By this time, however, the era of heavier rails had come in the United States. For many years British roads had been using those weighing 80 and 90 pounds a yard, while those in this country seldom exceeded 50 or 60 pounds. In 1887 the Pennsylvania Railroad contracted with the Cambria Iron Company and the Edgar Thomson Steel Works for 70-pound rails, and put down experimentally on some of its heavy traffic sections a few 90-pound English rails.[18]

[15] American Iron and Steel Association, *Bulletin*, xx, 116, May 5, 1886.

[16] American Iron and Steel Association, *Bulletin*, xx, 173, June 30, 1886; xx, 220, Aug. 18 and 25, 1886; xxi, 141, May 25, 1887; National Association of Wool Manufacturers, *Bulletin*, xvi, 116–117, June 1886.

[17] American Iron and Steel Association, *Bulletin*, xx, 137, June 2, 1886.

[18] *Boston Journal of Commerce*, Apr. 25, 1885; American Iron and Steel Association, *Bulletin*, xxi, 164, June 22, 1887.

THE POOL CONTROVERSY

The Steel Rail Association admitted the mills at Springfield, Illinois, in 1877, and at its meeting in the autumn of that year, while fixing total output and the quota of each member as usual, named no definite figure as the maximum price for rails. It was "believed that $32.50 or $33 at the mill would be the bottom price for roads in the East, with the usual addition for western deliveries." In a report of the meeting the statement occurs that—

"Representatives of some of the leading companies said that if any of those present wanted orders at less money, they might fill them up as soon as they chose, and that the others would be quite willing to take their chances of a later demand."

The Rail Association was the object of bitter attack, especially by free-trade and low-tariff organs. In its defense, the prices of steel rails since 1867, when they commanded $166 a ton, were quoted. These showed a pretty consistent decline until 1885, when a minimum of $28.50 was reached. In 1887 prices had recovered to $37.13 a ton, which was more than in any previous year since 1883. The defenders of the "trust" argued that with the unprecedented railway construction of 13,000 miles of new line in 1887, every mill in the country would in any case have been rushed with work, and prices would inevitably have risen to the maximum of the season which was $40. There was a decided drop the last half of the year to $31.50, which was considered sufficient proof that the Association did not control the market.[19]

In 1888 the Colorado Coal and Iron Company rolled rails for the Seattle, Lake Shore, and Eastern Railroad. This was said to be the first order of steel rails ever sent to the Pacific Coast by works west of the Missouri River. The price of steel rails was very low again this year, the Pennsylvania Railroad Company making contracts with three makers in Pennsylvania for the delivery of 45,000 tons at $28 a ton. Even this was a rather better figure than had hitherto been asked for immediate delivery. This season the North Chicago Rolling Mill Company had the largest output of any firm in the country, producing 162,000 tons of steel rails, while the Carnegie Works and the Scranton Steel Company practically tied for second place, each turning out slightly under 140,000 tons. The length of steel rail trackage in the United States first exceeded the length laid with iron rails in 1883, and by 1890 it was three-fourths of the total.[20]

MECHANICAL IMPROVEMENTS

Machinery for making steel rails had been so perfected before 1890 that no more manual labor was involved in their production than that required

[19] American Iron and Steel Association, *Bulletin*, XXI, 220, Aug. 17, 1887; XXI, 324, Nov. 23, 1887; XXII, 43, Feb. 8, 1888.

[20] American Iron and Steel Association, *Bulletin*, XXII, 213, July 4, 1888; XXII, 330, Nov. 7 and 14, 1888; XXII, 342, Nov. 21, 1888; XXIII, 36, Feb. 6, 1889; XXIV, 235, Aug. 20, 1890.

to move a lever or to turn a wheel, from the time the ore, flux and fuel were dumped into the charging buggies that fed the furnace until the finished rail was ready for the straightener or drill press. Steam, air and water performed the severe work that made it possible for a modern mill to turn out every 25 seconds a 30-foot rail weighing 600 pounds, so perfect that variations of small fractions of an inch in thickness or contour were sufficient to insure rejection. The number of men and boys employed upon the rail, from the time it was delivered to the blooming train until it had reached the cooling bed, was 17, and the cost of this labor aggregated about 8 cents per ton. At North Chicago approximately a mile of finished rail was completed every hour of the working day. During 1890 there was some dispute as to the labor cost of producing a ton of rails from the extraction of the raw material until the completion of the finished product. According to figures presented by the steel manufacturers themselves, the labor cost alone of producing a ton of pig iron was at this time $10.47. The additional labor used in converting the pig iron into ingots, blooms and rails raised the total to $19.29. The United States Commissioner of Labor had recently placed the direct labor cost of making a ton of steel rails from the iron at about $11.59.[21]

Heavier rolling stock and higher average speeds on railways had now fully inaugurated an era of correspondingly heavier rails, and such rails were subjected to tests that would have been considered absurdly excessive only a few years before. In 1891 the Bethlehem Iron Company rolled 10,000 tons of steel rails weighing 95 pounds to the yard for the Boston and Albany Railroad, and the following year the New York Central replaced the 80-pound rails recently laid down upon its Hudson River Division with 100-pound steel rails of American manufacture. The rails rolled by the Illinois Steel Company increased in average weight from 63.75 pounds per yard in 1889 to 68.10 in 1892. In 1891 the Maryland Steel Company began to roll rails at its Sparrows Point plant, which was soon to begin supplying to several southern lines at whose terminals deliveries could be made by water.[22]

While the production of steel ingots and castings increased almost uniformly, with one or two exceptions, during every succeeding season from 1880 to 1893, the quantity of steel rails produced fluctuated widely. Beginning with 852,000 tons the first year mentioned, it rose to well above a million during the three following years, reaching 1,284,000 tons in 1882. Then a decline began and in 1884 and 1885 the output fell well below a million tons. With the revival of railway prosperity and the new construction inaugurated in 1886 another record of over a million and a half tons was made; and the output rose to over 2,100,000 tons the following year. This

[21] American Iron and Steel Association, *Bulletin*, XXIII, 9, Jan. 16, 1889; XXIV, 237, Aug. 20, 1890; *Ex. Doc.* No. 265, 51st Cong., 2d sess., 173–177.

[22] American Iron and Steel Association, *Bulletin*, XXV, 213, July 22, 1891; XXVI, 313, Oct. 26, 1892; XXVI, 333, Nov. 9 and 16, 1892; XXVII, 133, May 3, 1893; *Iron Age*, XCIII, 1014–1015, Apr. 23, 1914.

remained a maximum not equaled until 1899, twelve years later. In 1893 the output fell to 1,130,000 tons, and in 1894 to 1,016,000 tons.[23]

STREET RAILS

As long as horses were used upon street railways the light flat rails employed, averaging nor more than 30 or 35 pounds to the yard, did not constitute a large item in rolling-mill tonnage, nor did important works compete keenly for this market. With the introduction of electric traction during the eighties a complete reversal of this situation occurred. The old flat rail would not stand the weight of electric cars with their heavy machinery, and a rigid track was necessary for proper operation. This caused the old tracks to be taken up and replaced within a comparatively short period, and created a large market for the heavy rails which were substituted for the flat rails just described. Since these were generally laid in paved streets they were of girder construction, 8 to 10 inches in depth, to allow the paving stones to fit between the head and web of the rail. The web or base was made wide to give the rail good support, or else it was omitted entirely, and a broad bar considerably wider than the head was welded to the girder at regular intervals. The result was that the street car rails became heavier for a time than the rails used by steam roads, weighing from 80 pounds to as high as 112 pounds a yard. The economy in employing such heavy rails came partly from their greater length of life under continuous traffic, because the cost and inconvenience of relaying rails in crowded city streets, where expensive paving must be renewed and short interval service must be maintained along the line during replacement, made it cheaper to put in an expensive rail than to have frequent renewals. In addition the reduced jarring of the cars and their machinery where heavy rails were used lessened repair bills on rolling stock.[24]

LOCOMOTIVES FOR EXPORT

It will be recalled that some of the first locomotives built in the United States were exported to Europe. During the early seventies the foreign market for this class of machinery again absorbed an appreciable fraction of the American output. Brazil, Russia and Canada were our principal customers at this time. In 1873 the Baldwin Works delivered a large consignment of locomotives to the Dom Pedro Railroad of Brazil and the Grand Trunk Railroad contracted for 300 new engines in the United States. These were to be coal burners to replace the wood burners previously in use.[25] Such orders, however, were not sufficient to sustain the prosperity of our locomotive makers during the ensuing panic and depression. The Baldwin Works, which employed 2,800 men and were building locomotives at the

[23] *Manufacturers' Record*, LXVI, 40, Oct. 15, 1914; *cf.* American Iron and Steel Association, *Iron and Steel, Iron Ore, and Coal Statistics, to the end of 1901*, p. 16.

[24] American Iron and Steel Association, *Bulletin*, XXVII, 146, May 17, 1893.

[25] American Iron and Steel Association, *Bulletin*, VII, 268, Apr. 23, 1873; VII, 354, July 9, 1873.

rate of 500 per annum previous to September 1873, were compelled the following year to reduce their force to 1,400 men, working part time, and were building at the rate of 160 locomotives per annum. Of the 437 complete locomotives this Company turned out in 1873, 96 were for foreign markets, and of the reduced number under construction the following year a majority were for export.[26]

In 1874 the Grant Locomotive Company of Paterson, New Jersey, became involved in difficulties, which eventually led to the appointment of a receiver, on account of their inability to deliver in contract time an order for 55 locomotives placed with them by the Russian Government. The reason for this default was that these locomotives were to be built "on the European plan," and their manufacture required heavier machinery than was used in making those of American model.[27] The resumption of locomotive exports to Russia, which for some years had been building its rolling stock at home, or buying from Germany, France and Belgium, was due to the fall in prices after the high levels following the Civil War. All locomotives shipped to that country at this time were wood burners, and according to a State Department report it was an agent of the Baldwin Company who first brought to the attention of the Russian railway authorities the fact that it would be possible to use as fuel the excellent steam coal available at certain points in southern Russia. This resulted in the introduction of heavier coal-burning locomotives, with a tractive power of 1,075 tons, in place of the light wood burners pulling only 700 tons previously in use.[28] At this time the Pullman Works shipped sleeping cars to Great Britain and Europe, and the Troy Car Works made cars for Australian roads.[29] Steel axles were imported from Great Britain, though some of excellent quality were also made in the United States. On the other hand American foundries shipped occasional lots of car wheels to England and South America.[30]

A revival, in this branch of manufacture was already perceptible in 1875, and was still more marked the following year. Since its first shipment abroad in 1838, the Baldwin Locomotive Company had exported 389 locomotives, valued at more than $5,000,000, of which 96 were delivered in 1873. During the Centennial Year this Company celebrated the completion of its four-thousandth locomotive. Since 1870, 395 American locomotives had been sold for use on foreign railways and contracts for a large additional number had been concluded. About this time steam street motors had a period of transient popularity and several were built for different American cities.[31]

[26] American Iron and Steel Association, *Bulletin*, VIII, 139–140, Apr. 30, 1874.

[27] American Iron and Steel Association, *Bulletin*, VIII, 321, Oct. 29, 1874; IX, 45, Feb. 19, 1875.

[28] American Iron and Steel Association, *Bulletin*, XX, 276, Sept. 10, 1875; *cf.* Massachusetts Railroad Commission, *Report for 1872*, p. ccxix.

[29] American Iron and Steel Association, *Bulletin*, VIII, 348, Nov. 19, 1874; IX, 66, Mar. 12, 1875.

[30] American Iron and Steel Association, *Bulletin*, IX, 193, July 2, 1875; IX, 233, Aug. 6, 1875.

[31] American Iron and Steel Association, *Bulletin*, X, 138, May 10, 1876; X, 261, Sept. 27, 1876; XI, 149, May 30, 1877; XI, 198, July 18 and 25, 1877.

NEW MARKETS AND MODELS

From this date until 1882 American locomotive works were fully occupied with both domestic and foreign orders. The Baldwin Works, which were regularly referred to as the largest in the world, manufactured more than 300 locomotives during 1878, of which 40 were shipped to Russia, and others were delivered to railways in Brazil, Peru, Cuba, Nicaragua, Norway, Italy, Australia and New Zealand. Locomotive prices had fallen from $10,000 in 1873 to $5,000 at this time, though the cost of production had not decreased proportionately. The most powerful engine manufactured up to this date was for a western railway and had a tractive power of 2,500 tons on a level. At this time the elevated railways of New York entered the market for light locomotives, inaugurating a demand that expanded constantly thereafter until electricity supplanted steam for urban and suburban traction. Among other advances in construction the so-called consolidation engine was developed, having eight driving wheels and a two-wheel truck with the tank over the boilers. Locomotives of this type weighed about 60 tons and were employed on the newly constructed Rocky Mountain divisions of our western roads.[32]

Steel axles were gradually displacing iron axles, but for some years their relative reliability and economy were disputed. There was no doubt that those of steel were stronger and resisted wear better than those of iron, but some roads had trouble because of their breaking. In addition they cost twice as much as the best iron axles and it had not been determined whether their additional wear would compensate for their higher price. The employment of iron and steel in the construction of freight cars was increasing. Some Pennsylvania coal roads had been using iron coal cars for several years, and what were called "all-metal cars" were built experimentally before the Civil War. But no railway shops or car manufacturers had as yet developed special machinery for making entire cars of iron and steel and, as they had highly specialized wood-working machinery for making wooden cars, it was certain that a transition to the new material would in any case be gradual.[33]

PRICE FLUCTUATIONS

Business improved steadily during the late seventies and exports of locomotives, especially from the Baldwin Works, continued to grow. By 1880 that firm was employing nearly 3,000 men, with orders accumulating, and by 1891 the establishment had enough work ahead to keep it running at full capacity for more than twelve months. A single contract with the Denver and Rio Grande Railroad for 144 locomotives, costing about $7,000 each, was reported to be the largest single order on record. For a brief

[32] Brassey, *Work and Wages*, 179; American Iron and Steel Association, *Bulletin*, XII, 302, Dec. 18, 1878; XIII, 13, Jan. 15 and 22, 1879; XIV, 205, Aug. 18 and 25, 1880.

[33] American Iron and Steel Association, *Bulletin*, XII, 121, May 22 and 29, 1878; XII, 147, June 19 and 26, 1878.

period prices of rolling stock rose very rapidly. Locomotives that in dull times could be bought for $6,500 commanded from $11,000 to $13,000, and box cars that two or three years before had fallen as low as $325 more than doubled in price; but, though demand continued active from 1878 to 1882, figures did not remain at this level for more than a brief period. In 1880 the Baldwin Works turned out their five-thousandth locomotive. The same season the Rogers Works of Paterson made the first shipment of American locomotives to Spain.[34]

Car building was as active as locomotive building. In 1881 the town of Pullman was founded, with large works for making Pullman sleeping cars and other rolling stock. This was one of the first examples of a model industrial town or "garden city" in the United States. Detroit was also an important car-making center. The Michigan Car Company at that place had a plant that covered 25 acres, employed 2,000 men, and built about 6,000 freight cars a year. The Detroit Car Wheel Company made 300 wheels a day.[35]

During 1880 and the two ensuing seasons the Baldwin Works surpassed their construction record of 1873 in number of locomotives built, and nearly doubled it as measured by tractive power, for the new engines were largely of the consolidation type, and the 557 completed at these works in 1883 were supposed to equal in motive power 800 locomotives of the type turned out ten years before.[36] Then came the slump of the middle eighties and in 1884 the Baldwin Works received no orders from abroad; although they completed engines on existing contracts for companies in Norway and South America.

Prices declined[37] to such an extent during the depression that the manufacturers of steel car axles tried to combine for the purpose of controlling output and quotations. These low prices seem to have resulted in inferior work and possibly they accelerated the displacement of cast-iron car wheels by steel wheels; for on some deliveries 25 per cent of the wheels supplied failed in service, probably because coke iron instead of charcoal iron was used to make them.[38]

GEOGRAPHICAL DISPERSION

By this time Alabama had become an important producer of foundry iron and was turning out large quantities of car wheels. In 1886 a firm at Roanoke, Virginia, secured under competitive bids, and at prices that

[34] American Iron and Steel Association, *Bulletin*, XIII, 91, Apr. 16, 1879; XIII, 139, June 4, 1879; XIII, 187, July 23 and 30, 1879; XIV, 205, Aug. 18 and 25, 1880; XV, 17, Jan. 19 and 26, 1881; XV, 27, Feb. 2, 1881; XV, 98, Apr. 20, 1881; XV, 146, June 15, 1881; XVI, 89, Mar. 29, 1882.

[35] American Iron and Steel Association, *Bulletin*, XV, 27, Feb. 2, 1881; XV, 283, Nov. 9, 1881.

[36] American Iron and Steel Association, *Bulletin*, XVI, 18, Jan. 18, 1882; XVIII, 13, Jan. 9, 1884.

[37] American Iron and Steel Association, *Bulletin*, XVIII, 109, Apr. 23 and 30, 1884; XVIII, 269, Oct. 15 and 22, 1884.

[38] American Iron and Steel Association, *Bulletin*, XVIII, 117, May 7, 1884; XIX, 131, May 20 and 27, 1885.

northern firms considered ruinously low, an order for 500 freight cars from the New York, New Haven, and Hartford Railroad Company. The castings and bar iron were supplied by Virginia firms, the white oak came from the neighborhood of the works at a much lower figure than most northern concerns were obliged to pay, and the wheels and axles were furnished by the railroad company. The same firm secured additional contracts from New England railways and began to manufacture locomotives as well as cars, supplying twelve of an unusually heavy type to the Norfolk and Western road in 1886. The Pullman Company furnished western railroads with great quantities of steel axles and draw bars; the Pennsylvania Company had three shops where it made not only all its own axles, but supplied several neighboring roads, and the Chicago and Northwestern Railroad had at Chicago one of the finest car shops in the country.[39]

According to an estimate made in 1886, the locomotive works and railroad shops of the United States had a capacity of 2,800 locomotives a year, or about 600 more than could be turned out in Great Britain. The latter country and the Continent together could make but a little over double the number made in the United States. The Baldwin Company, which could produce 600 locomotives annually, completed its eight-thousandth locomotive. It took twenty years after the works were established in 1832 to build the first 500 engines; the second 500 required eight years, number 1,000 being finished just before the outbreak of the Civil War; and of the 8,000 locomotives built by 1886, half had been completed within the decade immediately preceding. During these ten years more than one-fifth of the Company's total output was built upon foreign orders. Yet there were no striking signs of concentration in this industry. Several small plants for manufacturing car wheels and cars had recently been established in the West and Southwest. Two new firms were reported from Texas in 1887, and large works to build both cars and locomotives were erected in Alabama.[40]

In the spring of 1887 electricity and steam heat were introduced, for the first time in America, upon an express train between Boston and New York. The active railway building of 1887 was naturally followed by very large additions to equipment, and although the following season was one of reduced earnings and curtailment, the output of locomotives continued to expand. Although the total number constructed in the country was not accurately known, because some were built by local firms and by railway car shops, and it was difficult to distinguish between rebuilt locomotives and those entirely new, the 19 principal makers turned out 2,180 in 1888, and 66 railroad companies in the United States and Canada built 382. Of the 737 credited to the Baldwin Works, 272 were of the consolidation type,

[39] American Iron and Steel Association, *Bulletin*, xx, 57, Mar. 3 and 10, 1886; xx, 109, Apr. 28, 1886; xx, 221, Aug. 18 and 25, 1886; xx, 293, Nov. 3 and 10, 1886.

[40] American Iron and Steel Association, *Bulletin*, xx, 114, May 5, 1886; xx, 203, Aug. 4, 1886; xx, 301, Nov. 17, 1886; xxi, 37, Feb. 9, 1887.

the largest of which weighed 75 tons under steam without its tender. The number of freight cars built this year by 37 firms and 63 railroads exceeded 82,000, without taking into account those built by small makers and minor lines making no report of their output.[41]

TECHNICAL PROGRESS

Until 1889 all locomotives in the United States had single expansion engines. That year the Baltimore and Ohio Company constructed at the Baldwin Works a compound engine on the English plan. This locomotive consumed 20 to 25 per cent less fuel than those of the usual type, and on a trial run from Baltimore to Philadelphia gained 22 minutes on the previous schedule.[42] Rolling stock was increasing in size and steel wheels were being substituted rapidly for iron wheels, although the latter were still in good repute. In 1889 English capitalists bought a large foundry and engine shop at Fort Wayne, which had been in operation for several years and had made practically all the wheels and boilers for several Western railroads. This plant used iron from Alabama and was believed to be the largest producer of car wheels in the world. Bessemer cast-steel wheels made at Boston were used on 30 railroads, and had records of from 80,000 to 90,000 miles before turning off.[43]

In 1891 the manufacture of steel cars was taken up seriously, special works being erected for their construction at Harvey, Illinois. Previous experiments in this line had not proved satisfactory, but the new company started out with heavy orders ahead, and the Illinois Steel Company put ten steel cars into the coke-carrying trade this year.[44] Slowly but surely heavier locomotives of the compound type were coming into general use. In 1892 the Pennsylvania Company built a high-pressure compound passenger locomotive that weighed with its tender 112 tons and was designed to carry a boiler pressure of 200 pounds. The same year the Union Pacific Company completed a locomotive at its shops in Omaha rivaling the Pennsylvania locomotive in size and carrying 180 pounds steam pressure.[45]

COMBINATIONS

In the spring of 1892 the five principal firms manufacturing steam locomotives in the country took steps to form a combination; but the trust movement made no further headway in this industry at that time. A more notable event that year was the amalgamation of the four principal car companies of Detroit, the oldest of which dated from 1864. The new firm had a capital of $9,000,000 and its works, occupying 78 buildings, covered

[41] American Iron and Steel Association, *Bulletin*, XXI, 90, Apr. 6, 1887; XXIII, 10–11, Jan. 16, 1889.

[42] Depew, *One Hundred Years of American Commerce*, II, 342.

[43] American Iron and Steel Association, *Bulletin*, XXIII, 301, Oct. 30, 1889; XXIII, 341, Dec. 11, 1889; XXV, 45, Feb. 18, 1891.

[44] American Iron and Steel Association, *Bulletin*, XXV, 145, May 20, 1891; XXV, 221, July 29, 1891; XXV, 261, Sept. 2, 1891; XXV, 349, Nov. 25, 1891.

[45] American Iron and Steel Association, *Bulletin*, XXVI, 316, Oct. 26, 1892.

over 80 acres of ground and employed about 5,000 men. About the same time the United States Rolling Stock Company's extensive works at Anniston and Decatur, Alabama, and Urbana, Ohio, were sold at public auction to foreclose a first mortgage. The Baldwin Works employed more men than even the big amalgamation of car works at Detroit, and were reputed to have nearly three times the output of any other single establishment in the world. This year the company completed 1,335 locomotives, for roads in America and some 30 foreign countries, one of its most recent shipments having been to Palestine. But the shadow of the coming crisis already hovered over these works. A large number of men in all departments were discharged about the middle of the summer, and the plant was placed temporarily on a five-day weekly basis. The Pullman Company built during this year 314 sleeping, parlor, dining and special cars, and at this time controlled over 2,500 cars operating on most of the railways of the country.[46]

No other locomotive works secured the same publicity as those of the Baldwin Company, not only because these were reputed to be the largest in the world but also because they stood in the popular mind for America's industrial equality with foreign rivals, much as did the large sewing machine, watch and clock, and arms factories of that period. Like the Ford Automobile Works today they were a quantity production plant, whose large protected market at home and experience in meeting the needs of a new country gave them certain competitive advantages over British and European works, especially in satisfying the requirements of less-developed regions, where railways were still in the pioneer stage. During the quarter century ending with 1894 American makers exported 2,879 locomotives, besides those sent overland to Canada and Mexico.[47] Paterson, which had the Rogers Works, for many years the second in size in the country, and two other establishments, could turn out in aggregate about as many locomotives in a year as the city of Philadelphia. Pittsburgh was another important center. About 1890 the Schenectady Locomotive Works became the second largest makers in America. The only plant in the South, at Richmond, was also a prominent establishment. But Pennsylvania easily led the states in this industry, as she did in nearly every branch of iron and steel making and engineering. According to the census of 1890 she made 1,204 of the 2,409 locomotives produced in the country, and contained 5 of the 19 active establishments.[48]

[46] American Iron and Steel Association, *Bulletin*, XXVI, 117, Apr. 27, 1892; XXVI, 205, July 13, 1892; XXVII, 145, May 17, 1893; XXVII, 253, Aug. 23, 1893; *Commercial and Financial Chronicle*, LVI, 208, Feb. 4, 1893; LVI, 887, May 27, 1893; United States Industrial Commission, *Reports*, XIV, 231, 234.

[47] Depew, *One Hundred Years of American Commerce*, II, 342.

[48] Depew, *One Hundred Years of American Commerce*, II, 340–341; Eleventh Census, *Report on Manufactures, Selected Industries*, 499–501.

CHAPTER XXIX

IRON AND STEEL SHAPES

IRON AND STEEL BRIDGES

American bridges attained at an early date a reputation extending beyond the borders of the country. Long before 1873 designs had been perfected and parts had been standardized so as greatly to cheapen the cost of production and to shorten the time required for filling orders and for erection. Bridge works were scattered all over the country, one firm of considerable local importance having its headquarters at Iola, Kansas, but the center of the industry was in Pennsylvania and Ohio.[1] In 1874 the Phoenixville Bridge Works replaced a wooden bridge 600 feet long over the Saco River at Biddeford, Maine, which had been destroyed by fire, within 40 days of the date of receiving the order and 44 days after the date of the fire. In spite of the depression following the panic of 1873, business continued fairly active. For example, the Phoenixville Works had orders for bridges from Canada and South America, from the United States Government, and from several American railways.[2] In 1868 William Sellers, head of a great machine manufacturing firm, organized the Edgemoor Iron Company, which furnished the iron work for the principal Centennial buildings and the Brooklyn Bridge. In the development of this business he employed in bridge construction and other structural work the distinctively American methods of standardization and manufacture by automatic and semi-automatic machinery that were applied more than 40 years later, under the stress of war, to the production of fabricated ships. This involved designing special hydraulic machines, large multiple punches, riveters, boring machines and the like, for this express purpose.[3] Some of the principal manufacturers of structural iron were kept going during the dull period of the middle seventies by the heavy demand of the elevated railways in New York, and by the active railway building in Canada. In 1878 and 1879 the orders for elevated railway iron filled by a single firm at Phoenixville, Pennsylvania, aggregated 40,000 tons, which was surmised to be the largest single iron contract ever made. In 1877 the Keystone Bridge Company erected the longest truss span in the world across the

[1] American Iron and Steel Association, *Bulletin*, VII, 187, Feb. 12, 1873.

[2] American Iron and Steel Association, *Bulletin*, VIII, 108, Apr. 2, 1874; IX, 115, Apr. 23, 1875.

[3] Roe, *English and American Tool Builders*, 249–250.

Ohio River. Within a few years the maximum span of iron bridges had risen from 320 feet to 515 feet in the great bridge at St. Louis, and to 519 feet in the span just mentioned over the Ohio.[4]

Although the bridge over the Mississippi at St. Louis was sometimes referred to as of steel, the first all steel bridge in the country, and possibly in the world, was formally opened in 1879. This was built by the Chicago and Alton Railroad over the Missouri River at Glasgow; and though its approaches consisted of iron trestles, its three main spans, each more than 314 feet in length, were entirely of steel. The same year the Edgemoor Iron Company concluded a contract for more than 5,000 tons of steel with the Trustees of the Brooklyn Bridge, which was reported to be the second bridge ever built whose suspended structure was entirely of that metal.[5]

STRUCTURAL IRON AND STEEL

In 1881 it was noted in New York that land had become so dear and taxes so high that it no longer paid to erect five or six-story buildings in many parts of the city, and eight and ten-story edifices with elevators were replacing them.[6] But the employment of iron and steel in architectural work was as yet limited to the traditional uses that had been more or less common for the past fifty years; and most of the structural shapes produced were still for highway and railway bridges. Locomotives and freight cars had doubled in weight and capacity within a few years, compelling the replacement of many bridges by those of heavier construction. During 1881, for example, the New York, Pennsylvania, and Ohio Railroad Company built 45 new iron bridges in Ohio alone; and other roads were almost equally active in this direction. Ohio remained a center for this branch of the industry as long as bridges and other structural shapes were mainly of iron. In 1883 the Columbus Rolling Mills, originally erected to roll rails, finding that they could not compete with larger companies manufacturing their own steel, remodeled their plant to roll structural shapes. Great progress was made in rolling heavy beams about this time, blooms being shaped in a single heat into deck and I-beams from square ingots weighing considerably more than a ton. Meanwhile prices for structural work were declining, especially in the Central West, where bridges that had cost over $18,000 a few years previously were sometimes paralleled by superior structures for $11,000 or $12,000.[7]

About this time the tendency to substitute steel for iron, and to bring the great steel manufacturing companies hitherto concentrating largely upon rolling rails into this field of production, took definite form. In

[4] American Iron and Steel Association, *Bulletin*, XI, 308, Nov. 21 and 28, 1877; XIII, 20, Jan. 29, 1879.

[5] American Iron and Steel Association, *Bulletin*, XIII, 117, May 7 and 14, 1879; XII, 177, July 16, 1879.

[6] American Iron and Steel Association, *Bulletin*, XV, 75, Mar. 23 and 30, 1881.

[7] American Iron and Steel Association, *Bulletin*, XV, 259, Oct. 12, 1881; XVII, 245, Sept. 5, 1883; XVII, 325, Nov. 21 and 28, 1883; XVIII, 309, Nov. 26, 1884; XXI, 181, July 6, 1887.

1885 the North Chicago Rolling Mill Company began to make steel beams. The following year the New Jersey Steel and Iron Company, at Trenton—where the first I-beam ever rolled in the United States had been made several decades previously—succeeded in rolling 20-inch I-beams, though apparently of iron instead of steel. In 1887 Carnegie, Phipps, and Company placed machinery in their Homestead plant for rolling steel structural shapes on the continuous plan adopted for rails at the Edgar Thomson Steel Works of the same Company. Steel ingots were taken practically from the converter, heated, reheated, bloomed and shaped by machinery so arranged that all the handling was done automatically. At the same time the former rail mills at Homestead were remodeled into mills for rolling smaller structural shapes. This plant and its extensions did not mark the entrance of the Carnegie Company into this field of production but it greatly enlarged the firm's structural output and enabled large economies to be effected.[8]

In 1888, the year the new structural mills at the Homestead works went into operation, the North Chicago Rolling Mill Company began to roll 12-inch steel beams. That year, also, the Fort Pitt Iron and Steel Works at Pittsburgh were remodeled for the same purpose. In 1889 the beam manufacturers of the United States held a meeting at which they reduced prices from 3.3 cents a pound, the rate that had prevailed for some years, to 2.8 cents a pound, for either iron or steel. This action was taken in order to bring the cost of beams into line with other specialties and to promote their use for building purposes. It was hoped that this reduction would boost consumption from 75,000 tons, the existing figure, to 100,000 tons within a year.[9]

Skyscraper construction, which was to have such a stimulating effect upon this branch of the steel industry, began in 1891, when the Columbia Iron and Steel Company, of Uniontown, Pennsylvania, was awarded the contract for supplying the structural steel for the new Masonic Temple in Chicago. This building, twenty stories high and at the time the loftiest business structure in the world, required between 3,500 and 4,000 tons of steel for its skeleton frame. As in the case of bridges, each piece was exactly fitted, holes drilled, connections dove-tailed, and all connections adjusted for ultimate use before leaving the factory.[10]

PIPE AND TUBES

Cast-iron pipe had been manufactured in the United States since early in the century, and with the growth of cities and the introduction of municipal water works the market for such pipe gradually extended over

[8] American Iron and Steel Association, *Bulletin*, XIX, 329, Dec. 16, 1885; XX, 11, Jan. 13, 1886; XXI, 338, Dec. 7 and 14, 1887.

[9] American Iron and Steel Association, *Bulletin*, XXII, 157, May 16, 1888; XXII, 277, Sept. 12, 1888; XXIII, 13, Jan. 16, 1889.

[10] American Iron and Steel Association, *Bulletin*, XXV, 11, Jan. 14, 1891.

the whole country. For a long time it was made chiefly in eastern Pennsylvania and New Jersey; but with the growth of the market in the West many large establishments were erected in that section, for freight was an important item in the cost of this product. Early in the period we are now discussing one of the largest pipe foundries in the country was at St. Louis; but the concentration of furnaces making foundry irons at Chattanooga and Birmingham encouraged the transfer of this industry to that point. It cost less to make this pipe at Birmingham and to ship it to St. Louis than to ship Birmingham pig to St. Louis to make the pipe there. Consequently, while nearly half of the cast-iron pipe made in the United States continued to be produced in the old area in eastern Pennsylvania and New Jersey, a new center of importance grew up in the South, competing for western trade as far north as the Ohio and upper Mississippi Valleys, and as far west as the Pacific Coast and Japan.[11]

Cast-iron pipe, so far as we have record, was not used for piping oil or gas. The growth of the petroleum industry created, however, a very large market for wrought-iron pipe, a demand that was constantly growing throughout this period with the development of pipe lines from short feeders to railway shipping points into trunk lines connecting the producing fields with tidewater, distant cities and central refineries. This market was further extended in the eighties by the sudden call for many miles of tubes, some of large diameter, to convey natural gas from the wells to consuming centers. Another field for their employment, which led to the establishment of wrought iron and steel-riveted tube works of considerable importance at San Francisco, arose in the West, where great quantities of tubes and siphons were required to carry water for irrigation systems and hydraulic mining.[12]

During this period steel was substituted for wrought iron in many forms of tubing. The use of basic steel for this purpose was tried in 1884 with satisfactory results by the American Tube and Iron Company of Middleton, Pennsylvania. This steel was supplied by the Pennsylvania Steel Company, and was found upon experiment and analysis to be superior to that imported. Such tubing was lap-welded or riveted according to size, the secret of making solid drawn steel tubes being at this time limited to England and confined to tubes of rather small dimensions, though some of 4-inch inside diameter are mentioned as being imported.[13] These solid drawn steel tubes made directly from the ingot must be distinguished from another type of seamless tube used mainly for cylinders of larger diameter, produced by a process developed experimentally at Cleveland, Ohio, in the

[11] American Iron and Steel Association, *Bulletin*, xx, 117, May 5, 1886; xxv, 45, Feb. 18, 1891; xxvi, 83, Mar. 23 and 30, 1892; *Industrial South*, vi, 201, May 6, 1886.

[12] American Iron and Steel Association, *Bulletin*, xix, 229, Aug. 26, 1885; xix, 293, Nov. 4, 1885; xix, 325, Dec. 2 and 9, 1885; xxi, 325, Nov. 23, 1887; xxiv, 173, June 18, 1890; xxvi, 5, Jan. 6, 1892.

[13] American Iron and Steel Association, *Bulletin*, xviii, 91, Apr. 2 and 9, 1884; xviii, 113, May 7, 1884.

early eighties, in coöperation with men from Waterbury, Connecticut, the center of brass and copper-tube manufacturing in this country. This heavy steel tubing, which was used for house boilers, milk cans, fire extinguisher shells, whistles, locomotive tubes and similar articles, was drawn from open-hearth steel plates. The tensile strength of the steel was found to be increased about 25 per cent during the process of cold and hot drawing into cylinders.[14]

Lap-welded steel boiler tubes and pipes were already manufactured to some extent in this country, but in 1887 a new process employing artificial fuel gas for heating was introduced at Boston. As soon as the welding of steel pipe became an accomplished fact, its greater durability as compared with iron created a great demand for this product, although wrought-iron pipe continued to be used mainly or exclusively in building pipe lines both for oil and gas. In 1889 a firm at East Orange, New Jersey, invented machinery that produced spirally welded tubing. Four-inch strips of steel were fed into a machine in a flat ribbon, emerging "black pipe perfectly welded, straight, smooth, and beautiful." This pipe, of large dimension, was stronger than longitudinally welded pipe because ordinary pressure tended to close the spiral seam more tightly instead of opening it. It was said to be impossible by any pressure yet applied to spread such a seam, and even if the welding were imperfect, as sometimes happened with too rapid feeding into the pipe-making machines, the effect of internal pressure was to close a leak instead of opening it.[15] The Mannesmann process developed in Europe, by which the tube or pipe was rolled from solid steel bars, the machinery giving the metal a spiral motion and fiber as it took tubular shape, had not been introduced in America; but the so-called Kellogg process, employing hollow ingots and rolling the metal over a mandrel, had been developed in this country, and by it seamless steel tube was being made at Findlay, Ohio, in 1890, "at much less cost than lap-welded pipes, and of course, for less than cast iron pipes when the decreased weight and increased strength are considered."[16]

The following year the art of manufacturing cold-drawn seamless steel tubing, which we have mentioned as being limited to Great Britain where the secret was monopolized by two prominent companies, was successfully introduced in this country. The first seamless cold-steel tube made in the United States was produced at Shelby, Ohio, on July 24, 1891. American experts disguised as workmen are reported to have learned enough about the process surreptitiously in Great Britain to induce the makers there to disclose their methods and to coöperate in their introduction in the United States. The steel billets were imported from Sweden, and this tubing was

[14] American Iron and Steel Association, *Bulletin*, XIX, 109, Apr. 22 and 29, 1885.

[15] American Iron and Steel Association, *Bulletin*, XXI, 237, Aug. 31, 1887; XXIII, 122, May 8, 1889; XXIII, 337, June 19, 1889.

[16] American Iron and Steel Association, *Bulletin*, XXIII, 165, June 19, 1889; XXIV, 369, Dec. 31, 1890.

used principally for bicycle frames, a market which had acquired remarkable proportions within a very few years.[17]

By 1891 tendencies toward trade combination had appeared in this industry. In fact, as early as 1880 the manufacturers of cast-iron pipe got together and attempted to regulate prices, but the meeting broke up after a few days session without results. The concentration of the industry began in 1891 with the consolidation of four large works at Pittsburgh and vicinity, which were already owned by virtually the same stockholders, most of whom were Boston capitalists, into a single concern with a capital of $11,500,000.[18]

WIRE

The history of wire-making during these two decades is likewise characterized by the development of new uses that practically revolutionize the industry. In the early seventies this manufacture was still centered, as it had been from colonial times, in Massachusetts—principally at Worcester—and in Pennsylvania; twenty years later it had attained very large proportions also in the Central West. An important contract for steel wire, which was won by American makers in competition with those of Great Britain and Germany, gave a stimulus to this industry in the middle seventies, much as the erection of the elevated railway in New York about the same time gave an impetus to the production of structural iron and steel. This contract was for the wire for the Brooklyn Bridge which had been under construction for twelve years or more. When tenders for supplying the materials for the superstructure were called for in 1877, a manufacturer using Pittsburgh crucible steel won the competitive bid for 3,400 tons of wire, to be accepted subject to the most rigid tests then known, for making the cables to be strung between the piers. Keen rivalry developed between makers of Bessemer and of crucible steel prior to completing the specifications for this contract, but experiment proved that the latter alone would answer the purpose. American manufacturers at this time made much of the fact that the tender accepted was successful not only on account of the lower price, but also on account of the superior quality, as demonstrated by test, of the sample wire tendered.[19]

BARBED WIRE

The second great new demand for wire at this time was due to the invention of barbed wire for fencing. Plain wire fences had been used in America for sixty years or more, and were regularly manufactured around Philadelphia. About 1875 a combination wire and wood strip fence,

[17] *Pittsburgh Dispatch*, cited in American Iron and Steel Association, *Bulletin*, xxx, 257, Nov. 20, 1896.

[18] American Iron and Steel Association, *Bulletin*, xxiii, 34, Feb. 6, 1889; xxv, 213, July 22, 1891; xxv, 269, Sept. 9, 1891.

[19] American Iron and Steel Association, *Bulletin*, xi, 27, Jan. 31, 1877; xii, 289, Dec. 4 and 11, 1878.

carrying barbs, was developed in Illinois. This was almost immediately superseded, however, by the new process of attaching the barbs directly to the fence wire instead of to wood. In 1874 about 5 tons of this wire were manufactured. The following year the output suddenly rose to 300 tons. Three years later it exceeded 6,000 tons, and 10 years after the first sales were made the amount manufactured annually was well over 75,000 tons.[20] Large quantities were exported to Mexico and South America, and 50 companies with an aggregate investment of nearly $20,000,000 were engaged in its manufacture. The United States became within a few years the largest consumer of wire in the world and the industry suffered from the growing pains inevitable under such conditions; in fact patent litigation and questions of plant and company organization occupied the attention of manufacturers almost as much as did the problem of supplying their expanding market.

Until about 1890 the rolling of wire rods, the drawing of wire, and the manufacture of fencing were often conducted at separate establishments. Indeed a large proportion of the wire rods used in the United States were imported. Wire and screw manufacturers and makers of barbed wire opposed a projected increase in the duty of 30 per cent ad valorem upon these rods in 1882, partly on the ostensible ground that this would be a tax upon the farmers. Importations at this time were nearly 200,000 tons per annum and according to advocates of higher tariff rates every rod mill in the country was closed.[21] Partly as a result of the higher duties imposed in 1883, and partly because a growing market and the reduction of labor costs due to improved machinery and quantity production favored domestic makers, the capacity of American rod mills rose from 50,000 tons that year to more than 500,000 tons in 1890. Modern rod mills were built at Johnstown, Worcester, Cleveland, Pittsburgh, Beaver Falls, Braddock and Joliet, certain of which were among the largest in the world. There were also older mills, some dating back to the thirties, in the East, and the expansion of this industry was well under way before the tariff of 1883 was enacted. In fact that year witnessed the completion of the tenth establishment of this kind at Beaver Falls, where the first wire belting ever manufactured in the country was made in 1887.[22]

For ten or fifteen years an opinion prevailed in many quarters that it was cheaper for the manufacturer of fencing to purchase his wire from regular works than to draw it himself. Gradually, however, makers of fencing added wire-drawing departments to their plants and speedily found this a

[20] American Iron and Steel Association, *Bulletin*, xv, 285, Nov. 9, 1881; xvi, 293, Nov. 1, 1882; Washburn, *Industrial Worcester*, 154–155.

[21] U. S. Tariff Commission, 1882, *Report*, ii, 1467, 2057, 2248–2250; Committee on Ways and Means, 53d Cong., 1st sess., *Tariff Hearings*, 314; U. S. Industrial Commission, *Reports*, i, 1008.

[22] American Iron and Steel Association, *Bulletin*, xvii, 101, Apr. 11, 1883; xvii, 164, June 20, 1883; xviii, 268, Sept. 26, 1883; xxi, 357, Dec. 28, 1887; xxv, 13, Jan. 14, 1891; Committee on Ways and Means, 51st Cong., 1st sess., *Tariff Hearings*, 1152; Committee on Ways and Means, 53d Cong., 1st sess., *Tariff Hearings*, 314; Washburn, *Industrial Worcester*, 147.

great economy. Since they produced large quantities of wire of but one or two sizes, mechanical improvements were rapidly discovered and applied that reduced the cost of making these particular grades $3 or $4 a ton. This was accomplished mainly by using heavier machinery, by the greater expertness of the workers, and by improving the quality of steel wire rods, the metal by this time in universal use. Early in the eighties the wastage in drawing fence wire amounted to 100 pounds or more a ton; by 1890 it had been reduced to 40 pounds a ton.[23]

Naturally periodical overcompetition occurred in the barbed-wire business and the speculative character of the new industry invited pools and trust promotions. For a number of years prices were regulated under trade agreements. In 1887 the pool, known as the United Wire Company, embraced about fifty firms and was operating upon much the same plan as its contemporary, the Steel Rail Association. It is significant, either of the facts or the polemics of the industry, that an advance of prices ordered by this pool in 1888 was attributed to the action of a combination of foreign steel firms in raising the price of the rods they shipped to the United States.[24] A more formal attempt at consolidation was made the following year, when a project to organize a barbed-wire trust under an Illinois charter with a capital of $12,000,000, to be known as the Federal Steel Company, was carried nearly to the point of realization.[25] The next step forward was taken in 1891, when the Washburn and Moen Manufacturing Company, the largest makers of wire in the United States, who after bitterly contested litigation had secured control of the key patents used by fencing manufacturers, transferred these rights to an organization embracing the largest barbed-wire firms in the country, known as the Columbia Patent Company. The previous year the Washburn and Moen Company had bowed to economic necessity and added to its parent plant at Worcester, Massachusetts, a large establishment near Waukegan, Illinois, near sources of raw material and in the heart of the principal market for wire fencing, thus becoming physically part of the Western group. The Columbia Patent Company superseded the pool and was managed by John W. Gates. It had general offices at Chicago and was designed not only to monopolize patents but also to control prices. The latter object was attained by making the Company the exclusive sales agent for the goods made by the constituent members, who included 90 per cent of the producers. This arrangement violated the antitrust laws and in 1892, with the advice of Judge Gary, what was called "a gigantic barbed-wire trust" was formed under the name of the Consolidated Steel and Wire Company, with headquarters at Chicago. It embraced at the time of its organization five large manufacturers of barbed-wire fencing, with plants at St. Louis, Joliet, Chicago, Pittsburgh,

[23] American Iron and Steel Association, *Bulletin*, XXIV, 155, June 4, 1890.

[24] American Iron and Steel Association, *Bulletin*, XVIII, 90, Apr. 2 and 9, 1884; XXI, 29, Feb. 2, 1887; XXII, 27, Jan. 25, 1888.

[25] American Iron and Steel Association, *Bulletin*, XXIII, 322, Nov. 27, 1889.

and Allentown, Pennsylvania. Notwithstanding this concentration of control, however, prices of barbed wire declined between 1874 and 1893 from 20 cents to about 2 cents a pound, and quotations over long periods bore very little apparent relation to the degree to which the industry was monopolized.[26]

After many experiments, the Washburn and Moen Company perfected about this time a process by which steel wire could be made that would stand tension equal to copper wire. At Providence, Rhode Island, where many electrical goods were manufactured, exceedingly fine wire was drawn at this time through diamond dies and wound with silk for use in receiving instruments for ocean cables and in galvanometers. The smallest size made at this date was about 0.002 of an inch in diameter.[27] Many new uses for wire were discovered during these twenty years, and what had earlier been only occasional and tentative employments had developed into large fields of consumption. Wire laths were exhibited at the Centennial Exhibition in 1876;[28] window screens and other woven products were not novelties;[29] but the manufacture of these and a score of allied wire articles expanded tremendously. Altogether the wire output of the United States rose from about 40,000 tons in 1874 to 1,250,000 tons a quarter of a century later.[30]

NAILS

Among the prominent causes of this expansion was the transition from the universal use of cut-iron nails to the general employment of steel-wire nails, although in 1893 the latter had not entirely displaced the earlier type. Several old-fashioned slitting mills survived as late as 1883 around Boston and Philadelphia, where they were used occasionally to convert Norway iron into nail rods. But the demand for such rods was rapidly growing less and the slitting mills were recognized to be on the way to extinction. The struggle for survival in nail manufacturing at that time was two-fold, between iron and steel nails and between cut and wire nails.[31]

Iron nails were made from puddled iron, and the rigid resistance of the powerful puddlers' union that largely dictated conditions in the latter industry may have hastened the transition to steel; but this change was bound to occur eventually in any case. Except for puddling all the processes of making cut nails were mechanical and were mostly performed by automatic machinery.[32] Wire nails were manufactured from iron wire in

[26] American Iron and Steel Association, *Bulletin,* xxiv, 205, July 16, 1890; xxv, 61, Mar. 4, 1891; xxv, 69, Mar. 11, 1891; xxv, 205, July 8 and 15, 1891; xxv, 219, July 29, 1891; xxvi, 11, Jan. 13, 1892; xxvi, 195, July 6, 1892; xxvi, 357, Dec. 7, 1892; Washburn, *Industrial Worcester,* 153–156; Committee on Ways and Means, 53d Cong., 1st sess., *Tariff Hearings,* 319; U. S. Industrial Commission, *Reports,* i, 1008, 1032, 1033; Tarbell, *Life of Judge Gary,* 76–78.

[27] American Iron and Steel Association, *Bulletin,* xxvi, 66, Mar. 9, 1892.

[28] United States Centennial Commission, *Reports and Awards,* v, Group viii, 2.

[29] Depew, *One Hundred Years of American Commerce,* ii, 638–639.

[30] United States Industrial Commission, *Report,* i, 1008.

[31] American Iron and Steel Association, *Bulletin,* xvii, 276, Oct. 3, 1883.

[32] American Iron and Steel Association, *Bulletin,* xix, 338, Dec. 23, 1885.

the United States as early as 1873 and steel rods and Bessemer steel scraps were reported to be used for making nails at the Troy Works about two years later. But a decade or more of development was still to occur before either steel or wire began to attract wide attention in the nail trade.

In 1884 the Bellaire Nail Works in Ohio put two Bessemer converters into operation to make nail plates for their own machines, throwing about 150 puddlers and heaters out of work. Other plants in that vicinity and West Virginia made the same change about this time. Steel was said to work easier in the machines than iron, and steel plates were cheaper than iron plates. For some time, however, a prejudice existed against steel nails and also against wire nails, many claiming that steel was not as reliable as iron, and that nails made of that material were likely to break off next to the head. This criticism may have been true for a brief period while the new process was being introduced, for American steel, as we have pointed out elsewhere, was by no means of uniform quality at this time, but the fact that nails could be made more cheaply of steel than of iron was itself an inducement to produce a grade of the former metal that would be safe to use in this branch of manufacture. In 1885 four of the principal firms manufacturing iron nails in the Wheeling district, following the example of the Bellaire Works the previous year, associated themselves in a separate company to manufacture steel for their own consumption; and about this date other steel works were erected in the same vicinity for a similar purpose. By 1886 it was estimated that half the nails manufactured in the Wheeling district were of steel, and that steel nails could be made for ten cents a keg less than iron nails, even when the manufacturer had to purchase his ingots from an independent maker.[33]

Just as the new use of wire for fencing tended to concentrate the wire industry, which had previously had its home chiefly in the East, at the same Western cities that were already manufacturing agricultural machinery and other farm supplies for the Mississippi Vally and prairie market, so the substitution of steel for iron favored Western nail makers at the expense of those in the East. The latter had to purchase their steel mainly in the Pittsburgh district, and therefore to pay freight on their ingots from western Pennsylvania to eastern Massachusetts. This was a fatal handicap and consequently nail making rapidly declined in its old home in New England where it had been thoroughly established before the adoption of the Constitution.[34]

The art of making wire nails is said to have been introduced in America about 1873, by a German priest living near Covington, Kentucky. Small brads and furniture nails of this kind had been made in France for a long period, and for that reason they were known in America as French nails.

[33] American Iron and Steel Association, *Bulletin*, IX, 307, Oct. 15, 1875; XVIII, 125, May 14, 1884; XVIII, 241, Sept. 24, 1884; XVIII, 269, Oct. 15 and 22, 1884; XIX, 77, Mar. 18 and 25, 1885; XIX, 189, July 15, 1885; *Boston Journal of Commerce*, Jan. 2, 1886.

[34] American Iron and Steel Association, *Bulletin*, XVIII, 269, Oct. 15 and 22, 1884; XX, 237, Sept. 8, 1886.

About 1870 their manufacture was extending gradually in Germany, Belgium and France. They were made on machines that produced but one nail at a time, and therefore were much slower and less efficient than American machines for making cut nails from plates. The real development of the business in America began in the eighties, when new inventions greatly increasing the output of wire-nail machinery were made and perfected in this country. In 1884 the industry had received "quite an impetus;" it had not as yet "reached large proportions but bade fair to grow rapidly." About half a dozen manufacturers were already engaged in producing wire nails and new companies were being organized to enter the same field. Recent improvements in form and quality were reported to give the wire nail a perceptible advantage over the cut nail quite irrespective of cheapness of production; moreover the wire nail perforated a cleaner passage through the fibers of the wood and clinched better than its older rival.[35]

By 1887 the competition of wire nails was already seriously felt by cut-nail manufacturers, whose business, while not declining, had practically ceased to expand; and several of them added wire-nail machines to their plants. They also reduced their prices for those sizes of cut nails with which wire nails came into keenest competition, that is, the smaller and finer kinds. Wire-nail manufacturers made capital of the fact that there were more wire nails of the same length to a pound than there were cut nails. This rivalry led to formal tests by a committee of the Western Nail Association to show the relative holding power of the two types. These tests resulted in favor of the cut nail; nevertheless box makers, builders and other large consumers expressed a decided preference for the wire nail, because it could be driven into any wood without splitting it. In 1894 the output of cut and wire nails respectively was 2,425,000 and 5,682,000 kegs, practically all of steel.[36]

Wheeling was most distinctively a nail-making center of any American city, and thanks mainly to its works West Virginia ranked third among the states—after Pennsylvania and Ohio—in this industry.[37] During the expansion of primary iron manufactures in the South in the eighties several nail factories were established in the Alabama district. There were also older works in Virginia. This was a business profitably pursued at points where other forms of iron manufacturing were less likely to be successful. In 1880 the Omaha Iron and Nail Works, employing scrap iron and old nails as their raw material, were shipping their products to the Pacific Coast and even to Japan. A large nail manufacturing company began operations in San Francisco in 1883; and six years later it was manufacturing both cut nails and wire nails, the latter from wire rods imported from Bel-

[35] American Iron and Steel Association, *Bulletin*, XVI, 241, Sept. 6, 1882; XVIII, 101, Apr. 16, 1884; XVIII, 243, Sept. 24, 1884; XXI, 75, Mar. 27, 1887; XXV, 101, Apr. 8, 1891.

[36] American Iron and Steel Association, *Bulletin*, XXI, 234, Aug. 31, 1887; XXI, 301, Oct. 26, 1887; XXVI, 51, Feb. 24, 1892.

[37] American Iron and Steel Association, *Bulletin*, XI, 245, Sept. 12, 1877; XII, 108, May 8, 1878; XIX, 84, Apr. 1, 1885; XX, 60, Mar. 3 and 10, 1886.

gium. One of the best equipped plants in the country was at Everett, on Puget Sound, where a specialty was made of the manufacture of 12-inch spikes which were displacing more expensive bolts and nuts in dock and bridge construction. By 1890 nail-making had practically ceased at Pittsburgh, where the transition from cut nails to wire nails had been fatal to the industry.[38]

This was one of the best organized branches of the iron trade. A National Association gathering statistical information regarding output and trade conditions and regulating prices was in existence in 1873. Until 1875 the Western manufacturers were unable to form local combinations similar to those prevailing in the East. That year, however, the Western Nail Association met at Pittsburgh and fixed prices for the ensuing season. Thereafter meetings of the Western Nail Association, embracing mills at Pittsburgh and farther West, and of the Atlantic States Nail Association, embracing works in New England, the Central States and the Southern States east of the Alleghenies, were held regularly for the purpose of establishing a uniform scale of prices, and at times to agree upon curtailing output. Prices were fixed not only at the factory, but also for deliveries at the principal distributing centers, such as Chicago and St. Louis. At these meetings Pittsburgh manufacturers were usually advocates of maintaining the highest possible quotations, partly because their labor costs were more than those of their competitors, thus forecasting the final disappearance of nail-making from that city about 1890.[39] It seems usually to have been more difficult to secure an agreement for a general suspension than to fix prices of products.

In 1884 the Western Nail Association undertook to organize a pool for producing and selling nails. Its factories were divided into four districts, the first of which embraced Pittsburgh and vicinity; the second, Wheeling; the third, the mills along the Ohio River; and the fourth, the mills in Indiana, Wisconsin, and at St. Louis. A Board of Control, consisting of two members for each District, was chosen to regulate, in conference with the President of the Association, prices and production and to appoint agents to handle all nails manufactured by the members. Every Western mill was in the pool; but no attempt was made to induce Eastern firms to join, because the latter were fully occupied supplying their legitimate market. At this time the Eastern Association price of nails was about ten cents a keg lower than the Western price.[40]

Three years after the pool just described was organized, differences between Pittsburgh and Wheeling manufacturers caused the disruption of the

[38] American Iron and Steel Association, *Bulletin*, XIV, 235, Sept. 22 and 29, 1880; XVII, 122, May 9, 1883; XVII, 268, Sept. 26, 1883; XVII, 277, Oct. 3, 1883; XXIII, 18, Jan. 23, 1889; XXIV, 234, Aug. 20, 1890; XXVI, 157, June 1, 1892; XXVI, 325, Nov. 2, 1892.

[39] American Iron and Steel Association, *Bulletin*, VIII, 52, Feb. 12, 1874; IX, 44, Feb. 19, 1875; IX, 245, Aug. 13, 1875; XII, 91, Apr. 17 and 24, 1878; XII, 293, Dec. 4 and 11, 1878; XIV, 73, Mar. 24 and 31, 1880; XVII, 341, Dec. 12, 1883.

[40] American Iron and Steel Association, *Bulletin*, XVIII, 107, Apr. 23 and 30, 1884; XXI, 69, Mar. 16, 1887.

Western Nail Association. At this time the eastern nail manufacturers also experienced difficulty in agreeing upon policies and prices. A special meeting of the Atlantic Association was called in 1886 for the purpose of "securing greater harmony among manufacturers."[41] After the disruption of the Western Nail Association two new associations were formed, of cut and wire-nail manufacturers respectively. In 1889 the Western Cut Nail Association at a meeting in Wheeling adopted a new gage making the number of nails to a pound practically the same as in the case of wire nails, and at the same time lowering prices. The wire-nail association at this time included every manufacturer in the country.[42] Both cut and wire nails were exported, this trade being largely in the hands of Eastern makers, who manufactured their nails from imported rods and plates, and who were allowed a drawback equal to the duty paid on the imported material upon nails shipped out of the country.[43]

Another association in an allied branch of the industry, tack manufacturing, proved less successful, possibly because it attempted to exercise too strict control over its constituent members. This combination, which was known as the Central Manufacturing Company and was organized in the spring of 1882, embraced thirty-eight tack-making firms. Its avowed purpose was to maintain prices and curtail production; but so many competitors were attracted into the industry that overproduction ensued and four years later the new company was dissolved.[44] This business was highly concentrated geographically, 58 of the 92 firms in the country being in Massachusetts, whose factories operated over two-thirds of the tack machines in the United States and could undersell their other New England as well as their Western competitors. Taunton was the tack town, as Wheeling was the nail town, of the country. The great advantage that the Eastern manufacturer had over his Western competitor was the peculiar quality of iron employed. This came from Europe and had never been made in the United States. Doubtless, however, there were other and unrecorded influences at work producing this geographical concentration. One, at least, was the cost of carriage, which was relatively light per unit of value on tacks as compared with nails.[45]

STOVES

A tendency for the center of the stove manufacture to shift westward from its earlier seat at Troy and Albany, whither it had been attracted originally by the excellent molding sands on the upper Hudson, was observable before the period we are now discussing. To be sure New York

[41] American Iron and Steel Association, *Bulletin*, XX, 37, Feb. 10, 1886; XXIII, 269, Sept. 25, 1889.

[42] American Iron and Steel Association, *Bulletin*, XXI, 117, May 4, 1887; XXIII, 197; July 17 and 24, 1889.

[43] American Iron and Steel Association, *Bulletin*, XXI, 309, Nov. 2 and 9, 1887.

[44] American Iron and Steel Association, *Bulletin*, XX, 85, Mar. 31, 1886.

[45] American Iron and Steel Association, *Bulletin*, XXIV, 299, Oct. 22, 1890.

and Pennsylvania remained the chief stove producing states, and Massachusetts continued to hold a respectable position in the industry; but Illinois, Michigan, Missouri, Indiana and Tennessee were pushing to the front. Simultaneously a change occurred in the kind of iron used for making stoves. Scotch pig-iron, on account of its fluidity, which made its cast in sharp, clear, well-defined outlines the shapes and decorations employed in stove plates, had previously been mixed with American iron in the proportion of one part to three for the finer castings used in this industry. By 1873, however, a tendency to decrease the quantity of Scotch pig-iron was strongly in evidence, and the following year the proportion had declined, at least in some works, to about 10 per cent.[46] This change in materials alone removed one obstacle to the growth of the industry in the West, and to its firm establishment later in the foundry-iron districts of the South. But the chief reason for this trend was to get nearer the western market. America never exported stoves in large numbers, though occasionally Eastern works filled orders in Europe. The Reading Stove Company, one of the principal makers in the United States, shipped quite a number to Germany at one time and established a regular agency in that country; but the domestic architecture and conservative household traditions of Great Britain and Europe, as well as differences in climate, prevented the general use of American stoves abroad.[47]

After 1872, when the National Association of Stove Manufacturers was founded, this industry was one of the best organized branches of the iron trade. Its meetings regularly fixed prices for a specified period ahead on a basis of weight and quality, the rate per pound for the best stove castings being about one-fifth more for first-class stoves than for "common" stoves. At the Association's conventions papers of considerable historical and technical interests were read, and the proceedings were published in more or less permanent form. Among the influences tending to preserve and strengthen this Association was the double fact that it had to deal with one of the strongest and best organized labor unions in the United States, and that the capacity of American stove works was often double the quantity of stoves ordinarily manufactured. In 1875 statistics presented at the annual meeting showed that the stove foundries of the United States were able to turn out 1,500,000 stoves a year, while during the previous season they had manufactured only 852,400 stoves. Practically the same condition prevailed in 1878. At the convention held the latter year we probably catch an echo of the close association between organized employers and organized labor, in the Presidential address, which earnestly denounced the employment of prison labor in American industries. Wage questions were also a frequent topic of discussion. In 1843 the iron in a stove made about

[46] American Iron and Steel Association, *Bulletin*, VIII, 18, Jan. 15, 1874.

[47] Amercan Iron and Steel Association, *Bulletin*, IX, 45, Feb. 19, 1875; XI, 43, Feb. 14, 1877; XXI, 330, Nov. 30, 1887; XXIV, 77, Mar. 19, 1890; Depew, *One Hundred Years of American Commerce*, II, 361.

half of its cost; forty years later it represented only about 15 per cent of the cost. Between 1873 and 1893 the number of stove foundries in the United States declined nearly one-fourth, but the volume of business remained about stationary. This was due to the competition of central heating and the gas range, and to other conditions attending the growth of a large city population.[48]

[48] American Iron and Steel Association, *Bulletin*, VIII, 84, Mar. 12, 1874; IX, 45, Feb. 19, 1875; IX, 189, June 25, 1875; XII, 17, Jan. 23 and 30, 1878; XVII, 49, Feb. 21, 1883; XIX, 220, Aug. 19, 1885.

CHAPTER XXX

MACHINERY AND TOOLS

METAL-WORKING MACHINERY

American metal-working machinery was radically improved in design, materials and efficiency between 1873 and 1893. The building of such machinery, which had been confined largely to Philadelphia and New England at the beginning of this period, became an important industry west of the Alleghenies,[1] and New England shops originally devoted to heavier machinery found it more profitable, as competition sprang up at points nearer sources of raw materials and consuming markets, to turn to lighter classes of machine tools and mechanical equipment. The old Taunton Locomotive Works, once among the more important establishments of the kind in America, illustrated this tendency. By the middle eighties they were building almost entirely equipment for textile mills, a branch of the machine industry for which New England possessed many enduring advantages, historical and otherwise.[2]

Philadelphia was the most important seat of the manufacture of machines for working metal.[3] American designs were original for the most part, and this branch of the engineering industries, like the manufacture of wood-working machinery, locomotives and steam engines, had an independent development in the United States. At the time of the Paris Exposition of 1867, the British judges remarked that their own machinery had been extensively copied by French and German manufacturers, and that such modifications as had been made in British design were not always improvements. So far as American machinery was available for comparison, it gave evidence of more originality in design and construction, and of the employment of new principles than that of any other of Great Britain's competitors.[4] In heavy engineering machinery Great Britain remained unrivaled for many years after that date;[5] but there were devices of great importance, long familiar in America, that seem not to have been commonly known even in the better machine shops across the Atlantic. For instance,

[1] Roe, *English and American Tool Builders*, 261; *cf.* American Iron and Steel Association, *Bulletin*, IX, 196–197, July 2, 1875.

[2] American Iron and Steel Association, *Bulletin*, XXVI, 84, Mar. 23 and 30, 1892; National Association of Wool Manufacturers, *Bulletin*, IX, 27–31, Mar. 1879.

[3] Roe, *English and American Tool Builders*, 239.

[4] *Scientific American*, XVI, 350, June 1, 1867.

[5] *E.g.*, American Iron and Steel Association, *Bulletin*, XXV, 117, Apr. 22, 1891.

in 1875 it was noted as an important discovery at Sheffield that a disk revolving at a very high rate of speed—3,000 revolutions a minute—would rapidly cut through steel rails, although that device had been in common use for many years in the United States for cutting beams, angle irons and similar metal shapes, and the Cambria Works employed the same "cold saw" for cutting rails. But the development of high-speed tool steel as known in present machine-shop practice was due largely to the experiments and investigations of a group of American machine tool builders at Philadelphia soon after 1880.[6]

BOILERS AND ENGINES

During the early years of this period reliable boilers for producing steam under higher pressures than had ever before been known, though they would rank as low-pressure boilers today, and engines of a hitherto unprecedented velocity, were almost simultaneously developed. This was in response to the new demands made upon prime movers, first by the high efficiency and fuel economy requirements of the marine engine, and later by the invention of the electric light and the development of electric traction. While cylindrical boilers had already replaced the older type of rectangular, or box, boilers, with a marked increase in the pressure limit as a result, most of the former had hitherto been designed to generate steam from water circulating between the tubes. The expansive pressure of this steam naturally bore upon all points of the circumference of the boiler itself. Although in the effort to attain high pressures boiler walls were thickened and more heavily riveted than hitherto, they invariably expanded under the new stresses which it was now sought to employ. In order to remedy this, water-tube boilers were introduced. The expansion of the tubes with their relatively small diameters was much less under high pressure, and the effects of an occasional failure were much less disastrous than they were in the old type of boiler. It took years to perfect the connections between the water tubes and the boiler heads so that there was no leakage at the joints under high pressure. This was accomplished little by little and rendered possible the steam-driven central electrical station that we know today.[7]

Step by step with this development came improvements in the steam engine that made it possible to maintain even speed at high velocities. The best engines in use at the time of the Centennial Exposition, for instance, operated so unevenly that an electric generator driven by them produced a current of constantly varying intensity with a corresponding effect upon the lamps in the circuit that it served. For most purposes, a light that fluctuated erratically between its full-rated candle power and half that candle power or less was practically useless. Furthermore, the develop-

[6] American Iron and Steel Association, *Bulletin*, IX, 37, Feb. 12, 1875; Roe, *English and American Tool Builders*, 250–251.

[7] *Cf. Journal of the Franklin Institute*, LXII, 147, Aug. 1871; CII, 253–268, Oct. 1876.

ment of engines running at higher and more constant speeds resulted in economies in other branches of industry. The Porter-Allen engine, manufactured in Philadelphia, had been perfected in 1880, until it made 600 revolutions a minute when driving electric dynamos. But the substitution of a similar engine, running steadily even at 90 revolutions per minute under a varying load for the older type of engine running at a slower speed and varying its velocity with the load, fully doubled the production of rail mills by lessening the number of heats required in rolling and greatly reduced breakage and defects. Compound engines, and after the middle eighties multiple expansion engines, began to be employed in power houses and factories as well as to propel vessels; and steam pressures of over 200 pounds were common.[8]

MACHINE TOOLS

Other improvements multiplied the rapidity with which steel and iron could be shaped. The development of high-speed steel as the result of the work of Frederick W. Taylor and his associates in Philadelphia made possible much heavier cuts at higher speeds in machining metals, that more than doubled the output of a machine. Simultaneously, the station type of tools was introduced, enabling a succession of operations to be performed simultaneously upon the same piece of metal. The introduction of new and more active abrasives extended the use of grinding, both for the rapid removal of metal and for precision work. Standardization of machine parts, enabling speedy replacements and repairs, also became more general, and metal was worked to a much finer gage than before.[9] Certain works began to specialize in the manufacture of one or two types of drills or lathes or milling machines, and tool-making establishments of the first rank sprang up at several interior points, such as Hamilton, Ohio, and Rockford, Illinois. Cincinnati became one of the largest tool-building centers in the world—a development that began about 1880 and sprang indirectly from the old river traffic. Prior to and immediately after the Civil War, Cincinnati did the greater part of the engine building and repair work for the Ohio River fleet. When that trade vanished steamboat machinery builders turned their attention to this new industry. One of the first and the largest firms in this city building lathes, planers and drill presses decided to specialize upon lathes, and to place its orders for other types of tools with smaller shops or to sub-contract for them with foremen in its own works. This plan proved popular and soon the manufacture of tools, parts and attachments was distributed among a large number of relatively small shops turning out one or two specialties. Cincinnati was also one of the largest

[8] American Iron and Steel Association, *Bulletin*, XIV, 202, Aug. 18 and 25, 1880; XVIII, 274, Oct. 29, 1884; *Engineering Magazine*, XV, 106 112, Apr. 1898; XXIII, 45–51, Apr. 1902; *Boston Journal of Commerce*, XXX, 174, Aug. 13, 1887; XXX, 261, Oct. 15, 1887; XXXVIII, 87, May 16, 1891.

[9] Roe, *English and American Tool Builders*, 248, 277-278; *Journal of the Franklin Institute*, CXV, 357-386, May 1884.

centers in the world for manufacturing wood-working machinery. Cleveland likewise acquired a reputation during this period as a producer of high-grade machine tools.[10]

AGRICULTURAL MACHINERY AND IMPLEMENTS

The rapid development of the machine building industry was in response to a demand for its products created by the rapid expansion of metal-working industries producing consumption goods. Among the most important of these was the manufacture of agricultural implements and machinery, which though widely dispersed throughout the United States, exhibited a high degree of geographical concentration in respect to certain groups of products. New England continued to make a large proportion of the lighter agricultural implements produced, such as spades, forks, hand rakes and hoes. Harvesters, mowers, threshing machines and plows were made mainly west of the Alleghenies, and particularly in the state of Illinois, which by this time had superseded Ohio as the principal center of this industry. Ohio, Indiana and Kentucky were our great plow-making states; harvesters and mowers, though still manufactured to some extent at Troy and elsewhere on the upper Hudson, were made mostly in the vicinity of Chicago.[11] Presumably American agricultural machinery was the best in the world; at least, it was exported heavily both to foreign nations and to their colonies. Great Britain imported large quantities of mowers and harvesters from the United States, partly for redistribution to other foreign markets. One of America's largest customers for plows and farm machinery was Russia, whose representatives in 1877 placed a single order for 10,000 plows in this country. British merchants reported that American forks, spades and axes were superior and cheaper than those made in Great Britain.[12]

In 1888, 19 of the 21 manufacturers of reapers and mowers in the country organized a national association at a convention in Chicago, and two years later the leading makers of harvesting machinery, headed by Cyrus McCormick, William Deering, William A. Wood and the other prominent manufacturers, consolidated their interests under the name of the American Harvester Company, with a capital of $35,000,000. The new company employed about 50,000 men and had an output of 350,000 machines a year.[13]

TYPEWRITERS

In the late seventies a new invention, based on the idea first conceived abroad but developed to the point of practical application in the United

[10] Roe, *English and American Tool Builders*, 266–275; American Iron and Steel Association, *Bulletin*, XXIV, 347, Dec. 3, 1890.

[11] *Cf.* Tenth Census, *Report on Manufactures*, 686–688.

[12] American Iron and Steel Association, *Bulletin*, VIII, 189, June 18, 1874; VIII, 391, Dec. 24, 1874; IX, 27, Feb. 5, 1875; IX, 234, Aug. 6, 1875; X, 138, May 10, 1876; XI, 93, Apr. 4, 1877; XI, 124, May 2 and 9, 1877; Hillyard, *The New South*, 380.

[13] American Iron and Steel Association, *Bulletin*, XXIV, 372, Dec. 31, 1890.

States, added another light metal-working industry to the manufacture of arms, clocks, watches, sewing machines and other articles turned out by a distinctively American technique in factories producing interchangeable parts by automatic machinery. This was the typewriter, which C. L. Sholes and his early associates, after several years experimenting, had patented and perfected to the manufacturing stage in 1873. On March 1 of that year the promoters of this machine entered into a contract with the Remingtons, who had already built up a great private armory at Ilion, New York, to manufacture their new device. Eventually the Remingtons became owners of the business, which in time outranked the original armory in importance. We are told that over $250,000 had been sunk in the enterprise and 10,000 machines had been sold before the owners began to reap a profit from their undertaking.[14] The elaborate report of Manufactures of Interchangeable Mechanism published in connection with the census of 1880 contains no reference to typewriters. Ten years later thirty factories were engaged in making them and the annual product was valued at over $3,600,000.[15]

HARDWARE AND TOOLS

American hardware and tools had evolved patterns possessing the lightness, grace and handiness that characterized our agricultural implements, and they were produced by similar methods. These qualities created a demand for them abroad, and as we have seen, our axes continued to find a market, as they had even before the Civil War, in the English colonies and other undeveloped countries, and our saws were extensively exported to Spanish America. American vehicles, which were lighter and built upon different lines from most vehicles manufactured abroad, required a type of hardware suited to their peculiar construction. In several other fields, for instance builders' and furniture hardware, local tastes and habits created for our manufacturer what was practically a monopoly market.

Although a prejudice existed in favor of English steel for cutlery and the higher grade of tools, American makers shipped sufficient goods of this kind to Great Britain to attract attention there. The British Commissioner at the Centennial Exhibition in 1876 rated American edge tools and miscellaneous hand tools above those exhibited by any other country. He spoke highly of American cutlery and mentioned iron-bodied planes as an American invention. Our manufacturers excelled in making saw mill as well as other wood-working machinery, and in 1877 a Pennsylvania firm made a band saw 54 feet long and 8 inches wide to be used for sawing the large timber of California. In 1878 a British authority ascribed the growing demand for American cutlery in foreign markets where British makers

[14] Depew, *One Hundred Years of American Commerce*, II, 544, 545; Herkimer County Historical Society, *The Story of the Typewriter*, 30–108.

[15] Eleventh Census, *Report on Manufactures*, I, 316, 317: an excellent history of this industry, with illustrations of most of the early models, is published in *Das Technische Blatt der Frankfurter Zeitung*, VI, No. 25, Dec. 5, 1924.

previously had a monopoly, not to its cheapness, for it was dearer than Sheffield goods, but to its superior shape and finish. Improvements in machinery and processes steadily reduced the cost of manufacturing in the United States. Solid-handled steel table knives, which sold for $5 a dozen in 1867, were priced at one-fourth of that sum five years later. Machinery was used for many processes in the manufacture of such articles where hand work was still employed in Great Britain.[16]

At this time American makers manufactured very cheap goods as well as those of better quality, competing successfully in the field that later was occupied largely by German manufacturers. Cast-iron scissors and cast-iron razors were made in this country and served their purpose excellently—at least for a time. Some Connecticut establishments reckoned this cast-iron cutlery among their most important products. These were not combined cast-iron and steel articles which were considered superior to forged steel goods and which had the steel inner blade cemented on each plate—of a pair of scissors, for instance—by the fusion of the iron when it was poured into the mould; but were tools made entirely of cast iron similar to that used in malleable castings. This material was not suitable for tools subjected to shock, though it was sometimes made into ice picks, axes, hatchets and steak choppers. The goods were not an imitation, but were sold for what they really were. Their principal inferiority consisted in the fact that the chill that made the cast iron hard did not extend to a depth that allowed repeated grindings and resharpening.[17] American pocket-knife manufactories remained throughout this period small village industries, located on water powers and for the most part organized on a co-operative basis.[18]

In 1889 the American Axe and Edge Tool Company was formed at Pittsburgh to include all the manufacturers of these articles in the country. This corporation, which purchased outright the plants of its constituent works and operated them under the management of their former owners, had a capital stock of $4,000,000, employed 10,000 men and declared its object to be "not to advance prices, but to economize production by being able to purchase raw materials cheaper."[19] In 1893 several of the largest saw manufacturing companies in America consolidated under the name of the National Saw Company, which had a capital of $3,000,000. Two similar consolidations occurred among the manufacturers of locks and safes.[20]

[16] United States Centennial Commission, *Reports and Awards*, VI, XV, 5, 13, 18; *London Times*, quoted in American Iron and Steel Association, *Bulletin*, IX, 289, Oct. 1, 1875; London *Ironmonger*, quoted *ibid.*, X, 138–139, May 10, 1876; *ibid.*, XI, 197, July 18 and 25, 1877; XII, 163, July 10 and 17, 1878.

[17] *Van Nostrand's Engineering Magazine*, February, 1885, quoted in American Iron and Steel Association, *Bulletin*, XIX, 67, Mar. 11, 1885.

[18] Depew, *One Hundred Years of American Commerce*, II, 637.

[19] American Iron and Steel Association, *Bulletin*, XXIV, 43, Feb. 12, 1890.

[20] *Commercial and Financial Chronicle*, LVI, 206, Feb. 4, 1893; LVI, 246, Feb. 11, 1893; LVII, 21, July 1, 1893.

This tendency to consolidation was confined to only a few branches of the hardware industry, in the larger definition of the word; for despite the existence of some large establishments, like the Disston Saw Works, which as early as 1876 employed 1,200 men, no group of manufactures was more varied in respect to its processes and products, and few were more widely dispersed than this one. But the improvement of machinery and the extension of its use went on apace, with the inevitable consequence of higher plant investments, larger producing units, erratic fluctuations of output, and the other conditions that encourage, and indeed ultimately enforce, industrial combination. Between 1870 and 1880, the product of labor in modern plants was estimated to have risen one-fourth on account of mechanical improvements and one-fourth on account of better system, both of which were factors favoring large establishments.[21]

CLOCKS AND WATCHES

Clock works and watch factories represented the other end of the gamut, among industries employing metals as their principal raw material, from the engineering works that turned out locomotives and heavy machinery; but progress in both classes of establishments was along parallel lines—the larger use of automatic or semi-automatic machinery, increasing precision, and a more perfect standardization of products and their constituent parts. No radical change outside of this general line of development occurred in the American method of manufacturing time pieces. The factory idea had received its full application in this branch of industry before 1873. But new factories were established and old ones enlarged so that the output increased faster than even the rapidly expanding domestic market.

Clock making presented no noteworthy features to distinguish it from earlier periods, except the invention of the electric watchman's clock, which was perfected in the early eighties.[22] Watch making had begun to take precedence of the older industry, not only in its appeal to inventiveness and the sense of novelty, but also in value of product. It was conducted in larger establishments than clock manufacturing, as was natural in view of the greater amount of capital employed per operative.[23]

At the time of the Centennial Exposition, Europe woke up to the fact that Americans were manufacturing watches on a large scale by an entirely new system. The Waltham Company had an extensive exhibit at Philadelphia where all the steps in the process of making a watch by machinery were shown in their logical sequence.[24] The Swiss, who had succeeded the English as the principal suppliers of cheap and medium priced watches to America, were already aware that their market in this country was on the wane. Between 1870 and 1875 the number of Swiss watches brought into

[21] Tenth Census, *Report on Manufactures*, 712; American Iron and Steel Association, *Bulletin*, XII, 74, Apr. 3, 1878.

[22] *Textile Record*, IV, 215–216, Aug. 1883.

[23] Tenth Census, *Report on Manufactures*, 684; Eleventh Census, *Report on Manufactures*, I, 160–161, 322–323.

[24] U. S. Centennial Commission, *Reports and Awards*, VII, Group XXV, 88–96.

the United States declined from 330,000 to 134,000. This determined the makers to make an unusually elaborate display at Philadelphia, and simultaneously to study closely the new process of manufacture which had been developed here. The expert who performed the latter task reported that the Americans were already sending their watches to Europe, and sold annually in England between 20,000 and 30,000. They had even created a demand for their goods in the Indies and Australia, and they had established branch offices at Moscow and St. Petersburg. He continued:

> "I sincerely confess that I personally have doubted this competition. But now I have seen—I have felt it—and I am terrified by the danger to which our industry is exposed."[25]

Chronometers were not manufactured extensively in the United States at this date, it being the usual practice to import the parts from England and to finish and adjust them in this country; nevertheless, some chronometers entirely of American manufacture were exhibited.

In 1878, according to the American report upon the clocks and watches at the Paris Exposition, the average annual output per workman was only 40 watches in Switzerland, as compared with 150 watches at Waltham. At this Exposition six prizes were given to exhibitors from the United States, including a gold medal to the Waltham Company. Although American watch-making machinery had been introduced at one or two places on the Continent, the only machine-made watches shown were from this country. Elsewhere it was still the universal custom to make the parts by hand in separate shops and to assemble them at a central establishment under the eyes of the manufacturer whose reputation stood behind the finished product. Among the exhibits of the Waltham Company, designed to illustrate the precison of its processes, was a micrometer measuring 0.0025 part of an inch; and a still more delicate instrument, to detect variations of 0.0001 part of an inch, was then under construction in its factory.[26]

When the Tariff Commission of 1882 was holding its hearings in Boston, representatives of both the Elgin and the Waltham companies appeared before it to ask that the duty be removed from certain materials which they used, more particularly jewels and watch-face enamel. The latter was not at this time made in the United States. In their testimony, these gentlemen said: "Scarcely any hand labor is used in the manufacture of a watch." At this date the Waltham Company employed 2,000 and the Elgin Company 1,600 operatives. Swiss manufacturers were now using machinery similar to that used in America. The Elgin Company sold most of its movements in the home market, but the Waltham Company, which had been exporting since 1876, shipped about one-third of its product to foreign countries. Its largest customer was Great Britain, which dis-

[25] U. S. Centennial Commission, *Reports and Awards*, VII, Group XXV, 117; American Iron and Steel Association, *Bulletin*, XI, 43, Feb. 14, 1877.

[26] U. S. Commissioners to the Paris Exposition, 1878, *Reports*, IV, 405–415.

tributed part of its imports to the British colonies. These watches were of a higher grade than some of the Swiss watches, the very cheapest trade still resting in the hands of foreign makers. In fact American factories had received from the British Government large orders for railway watches to be used in India.[27]

Although several other companies were in the field, the Waltham and Elgin factories were reported, in 1884, to turn out two-thirds of all the watches made in the country.[28] The Hampden Watch Company, which was organized in 1877 to succeed the New York Watch Company, was making 400 watches a day ten years later at its factory in Springfield, Massachusetts. These works moved to Canton, Ohio, in 1888. Six years before the latter date another Ohio enterprise, the Columbus Watch Company, was organized at the town of that name, succeeding an older firm that had previously imported Swiss movements and finished them in America. But the most interesting, and distinctively American, enterprise of this period was the erection of a factory in the brass working town of Waterbury, at the heart of the Connecticut clock district, in 1879, to manufacture a cheap watch with only 58 parts and no jewels—in fact a sort of pocket clock. This Waterbury watch, the joy of the small boy of the eighties, was the pioneer of those ultra-democratic timepieces that soon became so characteristic a product of the industry in the United States.[29]

[27] U. S. Tariff Commission, 1882, *Report*, I, 653–654, 657–659, 972; National Association of Wool Manufacturers, *Bulletin*, X, 147, Apr. 1880.

[28] American Iron and Steel Association, *Bulletin*, XVIII, 227, Sept. 3 and 10, 1884.

[29] Abbott, *The Watch Factories of America*, 97–107, 115–116.

CHAPTER XXXI

NON-FERROUS METAL MANUFACTURES

ALUMINUM

In the non-ferrous metallurgical industries the most important event of the twenty years following the panic of 1873 was the discovery of commercial processes for reducing aluminum, and incidentally of the modern practice of electro-metallurgy of which this development was a part. Two new methods, both in their commercial application the work of Americans, were discovered or perfected almost simultaneously in 1885 and 1886, by E. H. and A. H. Cowles and by C. M. Hall respectively.[1]

Until these new processes were introduced the reduction of aluminum was essentially a laboratory operation. The American output in 1883 was only a little more than 80 pounds. Ten years later it had increased to 7,500,000 pounds, and the business was only on the threshhold of its future expansion. In August 1888 the Pittsburgh Reduction Company was organized to manufacture aluminum under the Hall patents, and that year works were erected at Pittsburgh for this purpose. They were enlarged and removed to a neighboring suburb two years later, and soon thereafter other works were erected at Niagara and elsewhere. At first Greenland cryolite was used, but Alabama and Georgia ores, which received preliminary treatment at works in East St. Louis, were soon substituted for these. Some of the earliest commercial uses of aluminum were in optical instruments, dental plates and similar light articles. Cooking utensils of this metal were first placed on the market in 1890. Aluminum was also used in steel alloys.

When the commercial production of this metal began, it commanded from $20 to $32 a pound. In 1889 the price in thousand-pound lots was $2 a pound, or half the lowest previous quotation on record. The following year the Pittsburgh works were making 400 pounds of aluminum a day from German ore; and the new works of this company were said to contain the largest dynamos in the world. Late in 1890 the Cowles Electric Smelting Company of Cleveland, Ohio, which was manufacturing aluminum alloys, cut its prices to one dollar a pound for the aluminum contained in its various products. The following year this firm began to manufacture

[1] *Mineral Industry*, I, 13–18, XIV, 13. H. F. Castner, another American, developed at this time a new process for producing sodium, which greatly cheapened its cost, and thereby the cost of the Cowles aluminum process, but not enough to enable the latter to compete successfully with the Hall method.

pure aluminum at its plant at Lockport, New York, which it sold for $1.25 a pound, reported at that time to be the lowest quotation in the world. As the price fell the uses of the metal rapidly extended. In 1891 it was called for as a coating for iron and steel in the specifications for the dome of Philadelphia's new city hall, where it was expected to reduce the weight of the tower by about 400 tons. At this time it was adopted for certain military equipment by the United States Government. In 1893 the price finally fell to 50 cents a pound in the United States, whereupon aluminum began to be rolled into light structural shapes.[2]

COPPER REFINING

A superficial similarity exists between the development of the aluminum industry and the radical revolution in copper refining resulting from the introduction of the electrolytic process. A couple of small plants of the latter type had been in operation at Phoenixville, Pennsylvania, and at Newark, New Jersey, prior to 1890, but the notable progress of this method dates from 1891 and 1892. The latter year there were some thirty electrolytic refineries in the world, producing 32,000 tons of copper annually. The following year 37,500 tons of electrolytic copper were produced in the United States alone, and the process was just at the beginning of a period of remarkable expansion which was to reduce the cost of refining to considerably less than half of what it had been hitherto.[3] We have already noted that our eastern copper smelters had in many instances grown up around earlier chemical works, where they were established to work up the pyrites cinder burned in the acid factories.[4] With the introduction of the electrolytic process, large refining plants were built accessible to water power in the West. Important works of this character were erected at Great Falls, Montana, in 1892, although much of the Montana ore was still shipped to Baltimore.

Although the United States became an important copper-producing country after the discovery of the mines in northern Michigan in the late forties, its product never exceeded 16,000 tons prior to the panic of 1873.[5] The following year some ten or twelve tons of copper a month were reduced in Pennsylvania from local ores, supplemented to some extent by ores received from Texas and New Mexico.[6] But compared with this trifling output, Michigan was producing well toward 20,000 tons per annum. The mines of that region, which ultimately narrowed down to the Calumet and Hecla, with a few minor competitors, were immensely profitable, producing

[2] American Iron and Steel Association, *Bulletin*, XXIII, 301, Oct. 30, 1889; XXIV, 53, Feb. 19 and 26, 1890; XXIV, 227, Aug. 6 and 13, 1890; XXIV, 285, Oct. 1 and 8, 1890; XXV, 51, Feb. 25, 1891; XXV, 85, Mar. 25,1891; XXV, 357, Dec. 2, 1891; XLI, 36, Apr. 1, 1907; Eleventh Census, *Report on Mineral Industries*, 278–282.

[3] *Mineral Industry*, I, 114, 125; V, 227.

[4] *Mineral Industry*, IV, 276.

[5] American Iron and Steel Association, *Bulletin*, VII, 205, Feb. 26, 1873.

[6] American Iron and Steel Association, *Bulletin*, VIII, 53, Feb. 12, 1874; VIII, 227, July 23, 1874.

copper for less than 10 cents a pound and selling it for approximately twice that amount.

In 1881, however, soon after the Southern Pacific Railway entered Arizona, the American copper market became unsettled and the Lake Superior companies shipped a surplus of some 3,000 tons to Europe. Eastern manufacturers were obtaining large supplies from San Francisco, which in turn received them from Arizona, where a single company, the Copper Queen, of Bisbee, was producing about 5,000 tons per annum. This new western competition caused a rapid fall of prices, although the Michigan mines speedily recovered control of the market by cutting their rates to a lower point than had hitherto prevailed.[7] In 1884 Lake Superior and Arizona copper sold at between 13 and 14 cents a pound, and Colorado copper smelted at Taunton, Massachusetts, at a cent under this quotation. The following year one of the important smelters of Baltimore failed, due to the shrinkage in value of its stock on hand.[8]

The United States as early as the middle eighties produced more than 30 per cent of the world's copper, and led all other countries in its output of this metal. Its smelters and refineries placed in the market some 74,000 tons annually, as compared with 49,000 tons in Spain and Portugal, the next largest producers. American smelters and acid makers still continued to import some pyrites and ores, but these made a comparatively negligible contribution to the country's total output. In the late eighties and early nineties about one-third of the copper mined still came from the Lake Superior region. Montana produced slightly more than this—the Anaconda mine alone having an output of well toward 30,000 tons a year, or 5,000 tons more than the Calumet and Hecla mines produced.[9]

Meanwhile the manufacture of copper and of brass continued to be concentrated mainly in Connecticut, in defiance of the fact that the natural-gas regions of the Middle West had cheaper fuel and many other districts had lower freights. The hold of the Naugatuck Valley brass workers, with their longer experience, upon the trade was to remain unshaken for an indefinite time to come; and between 1884 and 1895 the gross weight of the metal they consumed annually rose from 20,000 to 110,000 tons.[10]

LEAD

Although the lead output of the Missouri mines and the Galena district had fluctuated considerably in the past and the exhaustion of these deposits had been predicted, Missouri continued to be our principal lead-producing

[7] American Iron and Steel Association, *Bulletin*, XV, 203, Aug. 10 and 17, 1881; XIX, 169, July 1, 1885.

[8] American Iron and Steel Association, *Bulletin*, XVIII, 221, Aug. 27, 1884; XIX, 77, Mar. 18 and 25, 1885.

[9] American Iron and Steel Association, *Bulletin*, XIX, 229, Aug. 26, 1885; XXI, 157, June 15, 1887; XXII, 27, Jan. 25, 1888; Eleventh Census, *Report on Mineral Industries*, 155, 156; U. S. Geological Survey, *Mineral Resources of the United States, 1892*, p. 114.

[10] American Iron and Steel Association, *Bulletin*, XXIII, 299, Oct. 30, 1889; Lathrop, *The Brass Industry*, 101.

state up to the middle seventies and its yield was gradually increasing.[11] In 1878, however, some seventy tons of lead were shipped from San Francisco to Great Britain, an early indication that a new source had been developed. This was followed by the rapid development of the industry in Colorado, which on account of the proximity of rich silver lead ores and coal speedily became the chief producer of this metal. In 1893 Denver, Pueblo and Salt Lake City had the largest smelters in the country, although other plants were in operation in Montana, New Mexico and elsewhere. The Rocky Mountain establishments did not as a rule desilverize the bullion they produced, but shipped this for refining to Missouri and Illinois, the old center of lead smelting in America. Since this bullion was by no means invariably refined at the same works in the latter states that smelted the local non-argentiferous lead ores, but at plants specially designed for that purpose, this industry had apparently sought the old lead-smelting center partly in response to the attraction of occupational affinity, though to be sure it was also drawn there by the more solid inducements of convenient railway connections and cheap fuel.[12]

In 1889, after a period of fierce competition and tentative combination, the principal lead manufacturers of the United States formed a trust, which was said to control over 95 per cent of the country's output. Thirty-one different companies, including three large smelters, one of the best refineries and three linseed oil mills, were in the hands of this combination. These plants produced mainly white lead and also pipe and sheets, their annual output of lead and lead products being about 97,000 tons.[13] In the report for 1891, the President of the Company explained that the Trust did not have a monopoly of the lead-pipe business of the United States; it had no control of shot making; it was a large producer of sheet lead, but met active competition in that field. But the combination controlled an important share of the white-lead business, one-eighth of the country's linseed-oil output and one-eighth of its lead smelting and refining capacity. The latter branches of the industry were those that required a large liquid capital for the purchase of flax seed, ores and other materials.

That year this Trust was reorganized, like so many of its sister combinations, as a regular corporation, known as the National Lead Company, which owned 26 extensive plants in the eastern and central states engaged in the manufacture of white lead and other products. The following year an arrangement was made to combine this company with the American Linseed Oil Company, which we have described elsewhere. Both branches of the business experienced diminished prosperity in 1893, on account of the fall in the price of silver. The heavy losses of the oil mills were due to shrinkage in the value of the seed they held in their

[11] American Iron and Steel Association, *Bulletin*, VIII, 94, Mar. 19, 1874.

[12] Eleventh Census, *Report on Mineral Industries*, 168–173; American Iron and Steel Association, *Bulletin*, XII, 289, Dec. 4 and 11, 1878; *Mineral Industry*, VI, 425.

[13] *Commercial and Financial Chronicle*, L, 206, Feb. 8, 1890.

elevators, in sympathy with the declining gold price of Indian seed when silver fell to a lower level, while the lead works lost through the depreciation of their stock of ores. Nevertheless the Company successfully weathered this crisis and emerged from the panic unshaken.[14]

ZINC AND MINOR METALS

Zinc production followed the same course as that of the other industrial metals, the country's output of spelter rising from about 700 tons in 1873 to over 63,000 tons in 1890. This expansion outstripped the growth of the domestic market, although as recently as 1878 New Jersey ores were sent to Belgium to be reduced and metallic zinc was shipped from that country to America.[15] In 1890 the principal center of this industry was approximately coterminous with the Illinois-Missouri lead region, extending westward into Kansas. The smelters in this district produced mainly metallic zinc, while those in the older New Jersey-Pennsylvania center made most of the zinc oxide produced in the United States. A third area, in Virginia and Tennessee, was developing rapidly. Sheet zinc was rolled at but one establishment, situated in the West, and the largest consumers of spelter were the manufacturers of galvanized iron and of brass. Pennsylvania was the principal seat of the former industry, and Connecticut of the latter.[16] Combinations to control prices, which did not, however, develop into trusts, were organized in both of these branches of manufacture.[17]

Nickel was refined at Camden, New Jersey, from American ores during most of this period, but the importations of this metal, either pure or in an alloy with copper, were sometimes larger than the domestic output. New ore deposits were discovered and worked to some extent, notably in Nevada. The employment of nickel in combination with steel had not yet affected materially the market for this metal, which was chiefly used for coinage, plating and in the manufacture of German Silver.[18]

Several new alloys were discovered at this time. In 1887 a company was manufacturing phosphor-bronze in Philadelphia, and five years later Lieutenant Tobin of the United States Navy invented a new bronze considered superior to any previously known form of this metal. It was stronger than mild steel when rolled in rods and plates and was employed by the Navy Department for certain metal parts in war vessels.[19]

The production of mineral wool in the United States dates from 1875, three years after its discovery in Germany, when the first plant in America

[14] *Commercial and Financial Chronicle*, LII, 237, Feb. 7, 1891; LIII, 156, Aug. 1, 1891; LIII, 290, Aug. 29, 1891; LIII, 880–881, Dec. 12, 1891; LV, 1035, Dec. 18, 1892; LVIII, 262, Feb. 10, 1894.

[15] American Iron and Steel Association, *Bulletin*, XII, 244, Oct. 23, 1878.

[16] Eleventh Census, *Report on Mineral Industries*, 173–175; *Report on Manufactures*, I, 140–141, 204–205; *Commercial and Financial Chronicle*, LIV, 425, Mar. 12, 1892.

[17] American Iron and Steel Association, *Bulletin*, XVIII, 125, May 14, 1884; Lothrop, *The Brass Industry*, 123.

[18] Eleventh Census, *Report on Mineral Industries*, 269–273; American Iron and Steel Association, *Bulletin*, XVIII, 229, Sept. 3 and 10, 1884.

[19] American Iron and Steel Association, *Bulletin*, XXI, 61, Mar. 2 and 9, 1887; XXVI, 125, May 4, 1892.

was established at the Greenwood Furnaces in Orange County, New York. This substance is produced by forcing a jet of steam or air against a stream of molten slag, producing an incombustible material resembling asbestos, which was used as a non-conductor and a polishing agent. It was manufactured at the Isabella Furnace near Pittsburgh, and at the Salem Furnace in Virginia, as well as at the plant just mentioned, but was largely displaced later by asbestos.[20]

ENAMEL AND TINWARE

Granite-ware had been manufactured at St. Louis for many years, though even as late as 1877 some prejudice existed against its use on account of a prevalent superstition that it poisoned food. The old tinsmith dating back to colonial times continued to ply his trade and the manufacture of tinware was one of the few artisan industries where the use of machinery was limited and hand labor largely employed, in which the United States competed so successfully with Great Britain that our workers were able to import tin plates from that country, convert them into utensils and small articles of different kinds, and reship them to English markets. The manufacture of stamped ware out of tin plates, and iron plates subsequently tinned, was a labor-saving process brought to a standard of perfection in the United States unequaled elsewhere. In 1875 it was reported that pails with vertical sides 9 inches deep were being struck from a single piece and finished so as not to show a wrinkle.[21]

TIN PLATE INDUSTRY

The most spectacular event in American metallurgical history during this twenty years was the final establishment of the tin plate industry under the stimulus of the McKinley tariff. Terne plates, that is, dull plates coated with an alloy of tin and lead, had been made in Philadelphia by hand-dipping for more than half a century. But so far as we have record, this business was not continuously pursued and it never extended beyond one or two small establishments. In 1872 not a box of tin plate was manufactured in the United States; but four years previously the Cambria Iron Company had sent experienced representatives to Europe to learn the process of making them. Soon afterward a Pittsburgh manufacturer sent another representative abroad for the same purpose. Their reports were discouraging; for though all other conditions were favorable in the United States, the rate of wages prevailing in this country would, it was estimated, make it impossible for local producers to compete with foreign goods.[22]

Nevertheless the price of tin plates was so high in America at this time, ranging between $14 and $15 a box, that it encouraged three establishments

[20] American Iron and Steel Association, *Bulletin*, XVIII, 173, July 2 and 9, 1884; *Mineral Industry*, XI, 470–471.

[21] American Iron and Steel Association, *Bulletin*, IX, 211, July 16, 1875; X, 139, May 10, 1876; XI, 179, July 4, 1877.

[22] American Iron and Steel Association, *Bulletin*, VII, 147, Jan. 8, 1873; XXIX, 185, Aug. 20, 1895.

to undertake their manufacture in this country, and between 1872 and 1875 works were erected at Leachburg and Demmler, Pennsylvania, and at Wellsville, Ohio. They apparently made some polished plates; but their business dwindled speedily to the occasional manufacture of terne plates, which were used for roofing purposes and were manufactured with less expenditure of labor. In 1875 Rogers and Birchfield, of Leachburg, were utilizing the advantages of natural gas to manufacture a special quality of iron sheets suitable for tinning without the use of charcoal, and they were able for a time to make tin plates at a profit. In 1878 but two establishments remained in the business and both were limiting their output to terne plates. Manufacturers complained that importers and British producers had lowered prices with the express design of putting them out of business. Be this as it may, the cost of tin plate in America declined rapidly during this period. In 1879 the old firm of Phelps, Dodge and Company was reorganized, and one of its heads established tin-plate works in New York for making special sizes and kinds on orders, counting upon a market for their wares because they could fill such orders for specialties in much less time than was required to import goods from Europe.[23]

One reason why the progress of the industry was so slow in the United States was that the process of manufacture had scarcely advanced, so far as devices for economizing labor were concerned, beyond the practice of a century before.[24] A wayside memento of the vicissitudes of this industry is the record of the sale by the sheriff, in 1882, of the tin-plate works near Pittsburgh. About 1887 a company at Hubbard, Ohio, erected a small plant and exhausted its capital in an attempt to manufacture tin and terne plates from imported black-plates.[25]

In 1890, when the McKinley tariff was enacted, imposing a duty of 2.2 cents a pound on imported plates, none of these pioneer works survived as a going establishment. Sheet iron was in unusually active demand for other purposes and manufacturers hesitated at first to invest their money in tin-plate machinery on the strength of a rather unpopular law which might be repealed or amended at any time.[26] Nevertheless an enterprising company at St. Louis, already engaged in the production of stamped ware, soon added tin plates to its products, partly because it had an immediate market for the latter in its own factory.[27] Before the end of 1890 one of the largest can-making firms in the Union, Norton Brothers, of Chicago, imported tinning machinery from Great Britain and prepared to make its own steel, roll it into plates and tin the plates for its can factory, thus

[23] American Iron and Steel Association, *Bulletin*, IX, 209, July 16, 1875; IX, 225, July 30, 1875; X, 268, Oct. 4 and 11, 1876; XII, 68, Mar. 20 and 27, 1878; XII, 186, Aug. 14, 1878; XIII, 67, Mar. 19 and 26, 1879; XIX, 114, May 6, 1885.

[24] *Cf.* Dunbar, *The Tin Plate Industry*, 11.

[25] American Iron and Steel Association, *Bulletin*, XVI, 205, July 26, 1882; XXI, 115, May 4, 1887; XXI, 261, Sept. 21, 1887.

[26] American Iron and Steel Association, *Bulletin*, XXIV, 293, Oct. 15, 1890.

[27] American Iron and Steel Association, *Bulletin*, XXIV, 323, Nov. 12, 1890.

making the plant practically self-contained. The owners were induced to do this, not by an immediate prospect of cheapening the cost of the plates, but in order to avoid the uncertainties and embarrassments of obtaining their supplies from a country as distant as Great Britain. Hitherto they had bought $1,000,000 worth of tin plates abroad each year, and had improved their machinery within a decade so as to reduce the labor cost of making cans to one-tenth the former amount, though they were paying higher wages at the later than at the earlier date. An optimistic hope of accomplishing something similar in the manufacture of tin plates encouraged this Company in its new undertaking.[28] Before the close of the year other establishments were under way. One of these was the Demmler Company, which had started operations seventeen years before. These manufacturers in almost every instance used American black-plates, and indeed those employed at the pioneer McKinley Act establishments in St. Louis were made of southern basic steel from the Chattanooga district.[29]

By another year the industry was well established, though contemporary records of its progress bear abundant evidence of juvenile exaggeration and exuberance. Souvenirs of American tin plate were distributed by manufacturers. Banquets were held at which the viands were served on American tin dishes and the wines were drunk from American tin cups. The St. Louis Stamping Company found its new enterprise so successful that it immediately built special works of large capacity for this branch of its business and imported skilled labor from Wales to run its machinery.[30] In the spring of 1891 the tin-plate makers of the United States formed a temporary organization which eventually became the Tinned Plate Manufacturers' Association. The growth of this industry was heralded in the protectionist press as a dramatic illustration of the benefits of a high tariff, though other timely causes also contributed to this result, and consequently new enterprises received an unusual amount of publicity.[31] The simultaneous expansion of the steel output and the canning industry of the United States resulted in a juxtaposition of raw materials and markets that was almost sure to create sooner or later the connecting link between the black steel plate and the tin container. Moreover the technical backwardness of the tin-plate industry in Wales, where the trade was in the hands of conservative labor unions and no competition had hitherto existed sufficiently serious to compel improvement, was itself a temptation for Americans to try their hand in this new field and to pit their mechanical ingenuity against cheaper labor abroad.[32]

[28] American Iron and Steel Association, *Bulletin*, xxv, 2, Jan. 7, 1891.
[29] American Iron and Steel Association, *Bulletin*, xxiv, 363, Dec. 24, 1890; xxiv, 371, Dec. 31, 1890.
[30] American Iron and Steel Association, *Bulletin*, xxv, 5, Jan. 7, 1891; xxv, 26, Feb. 4, 1891; xxv, 61, Mar. 4, 1891; xxv, 93, Apr. 1, 1891.
[31] American Iron and Steel Association, *Bulletin*, xxv, 132, May 6, 1891.
[32] *Cf.* Dunbar, *The Tin Plate Industry*, 16–17; American Iron and Steel Association, *Bulletin*, xxv, 189, June 24, 1891; xxvi, 113, Apr. 27, 1892.

Nevertheless even the active promoters of the new industry exhibited at first a hesitating optimism. Some were inclined to devote their main attention to making terne or roofing plates, which required less skilled labor and experience. The fact that the United States did not produce tin in commercial quantities was used as an argument against the new industry. There were momentary periods of discouragement.[33] But substantial progress was made during 1891, and by the middle of the year thirteen firms in different parts of the country were already producing tin or terne plates or had under construction plants for doing so. Indeed the demand for black-plates for tinning at times exceeded the supply.[34]

By the autumn of 1891 American terne plates were reaching the Chicago market in carload lots and a year later domestic plates were used for roofing the World's Fair buildings in that city.[35] But the fact that the United States afforded the largest market in the world for tin cans for preserving food stuffs and shipping petroleum, and for other tin containers, inevitably concentrated attention on the manufacture of bright plates. Skilled workers began to flock to this country, under the double inducement of a call for their services at high wages in America and the depression in Wales itself, and confidence in the permanence of the protective duty increased as new works began to spring up in widely separated localities possessing more or less strategic political influence.[36]

Under a curious provision in the former tariff the duty upon tin plates was lower than the duty upon the sheet iron from which they were made. This encouraged the shipment of lightly tinned plates to this country to be used as sheet iron, as for example in the manufacture of stamped ware. The original coating was destroyed in stamping and the goods were retinned after they had received their final form. At equal prices American steel was preferred for stamping, however, and under the higher duty imposed by the McKinley Act the custom of importing English plates for this purpose speedily died out.[37]

The Government collected careful statistics of production in order to justify the duty, which had been opposed on the ground that it levied an indirect tax upon canned food and tinware and thus upon the poor man's dinner table. These statistics recorded a rapid increase of production. During the last quarter of 1891 eleven works were in operation and the total output of tin and terne plates was just over 1,400,000 pounds. During the first quarter of 1892, nineteen works were in operation and the product had risen to over 3,000,000 pounds, of which nearly 1,100,000 pounds were bright tin plates. These figures did not include stamped ware. Most of

[33] American Iron and Steel Association, *Bulletin*, xxv, 169, June 10, 1891.

[34] American Iron and Steel Association, *Bulletin*, xxv, Supplement, July 22, 1891; xxv, 202, July 8 and 15, 1891.

[35] American Iron and Steel Association, *Bulletin*, xxv, 269, Sept. 9, 1891; xxvi, 93, Apr. 6, 1892.

[36] *Manufacturers' Record*, xix, 6, July 4, 1891; American Iron and Steel Association, *Bulletin*, xxv, 245, Aug. 19, 1891.

[37] American Iron and Steel Association, *Bulletin*, xxv, 253, Aug. 26, 1891.

the works reported were in Pennsylvania.[38] The Tin Plate Association, representing sixteen firms, agreed in March 1892 upon uniform and standard piece rates for their employes, reported to be double those paid abroad. Quite naturally, a large tin-plate mill was soon erected at Baltimore, our largest canning center. At this establishment oil fuel was used.[39]

About this time several large Welsh tin-plate manufacturers either removed their works to America or set up branch establishments in this country. The earliest of these foreign enterprises were located near tidewater to use imported black steel plates from the parent factories.[40] Already the business had become a vested interest—alert to defend its legislative privileges, and at a meeting of the Tin Plate Manufacturers' Association in 1892, the question of duties "was thoroughly discussed."[41] The total output of tin and terne plates in the United States for the fiscal year ending July 30, 1892, was approximately 13,650,000 pounds; and during the ensuing fiscal year it reached in round numbers 100,000,000 pounds.[42] But the industry was as yet in its infancy, and not only its quantitative development, but also the mechanical improvements and the features of organization that were to give it a distinctively American character were yet to come.

Tin was known to exist in scanty quantities at several places in the United States. In 1885 a tin mining and manufacturing company was organized with headquarters at Amherst, Virginia. The first pig tin actually produced in the country, however, was smelted from ore found in the Black Hills of Dakota in 1886. These pigs weighed in the aggregate less than 200 pounds. The receipt of a block of tin weighing 25 pounds from the same district four years later was considered a matter of sufficient importance to receive comment in the newspapers.[43] More promising was the Temescal mine, opened in San Diego County, California, in 1891, which shipped over 26,000 pounds of block tin in its first consignment. Up to July 1, 1892, this company was reported to have produced about 140 short tons.[44] But these and other domestic sources of supply proved disappointing. In 1893 it was estimated that up to that date but 152 tons of tin had been produced in the United States, of which 134 tons came from California, 10 tons from Dakota, and 8 tons from Virginia.[45]

[38] American Iron and Steel Association, *Bulletin*, xxv, 290–291, Oct. 7, 1891; xxvi, 37, Feb. 10, 1892; xxvi, 124, May 4, 1892.

[39] American Iron and Steel Association, *Bulletin*, xxvi, 59, Mar. 2, 1892; xxvi, 113, Apr. 27, 1892.

[40] American Iron and Steel Association, *Bulletin*, xxvi, 121, May 4, 1892.

[41] American Iron and Steel Association, *Bulletin*, xxvi, 365, Dec. 14, 1892.

[42] Quoted from U. S. treasury statistics, in American Iron and Steel Association, *Bulletin*, xxvii, 292, Oct. 4, 1892.

[43] American Iron and Steel Association, *Bulletin*, xxii, 213, July 4, 1888; xxiv, 65, Mar. 12, 1890.

[44] American Iron and Steel Association, *Bulletin*, xxv, 202, July 8 and 15, 1891; xxv, 389, Dec. 30, 1891; xxvi, 97, Apr. 13, 1892; xxvi, 268, Sept. 14, 1892; *Cf. id.*, xxv, 132, May 6, 1891; xxv, 149, May 20, 1891.

[45] American Iron and Steel Association, *Bulletin*, xxvii, 211, July 19, 1893; Eleventh Census, *Report on Mineral Industries*, 249–256; *Mineral Industries of the United States*, 1892, 258.

CHAPTER XXXII

ELECTRICAL INDUSTRIES

ELECTRIC LIGHTING

Sir William Thomson, in reporting to the British Government upon the display of electrical devices, telegraphic apparatus and instruments of precision at the Centennial Exposition, covered the whole subject in less than two pages. At the Paris Universal Exposition, in 1878, this industry was represented by telegraph instruments, battery bells, electroplating apparatus and a few dynamos. An International Electric Exhibition was held at Philadelphia in 1884, but there were scarcely half a dozen exhibits from other countries. Yet only five years later the American Commissioners at the Paris Exposition of 1889 devoted 250 pages of their report to this subject.[1] At that Exposition the United States ranked next to France in the number of exhibits, having 28 of the 95 foreign displays. Of the 12 grand prizes in this department, France won 6 and the United States 4, and of the 52 gold medals, France took 30 and the United States 6. But this success was explained partly by the fact that some of the largest foreign manufacturers, especially from Germany, were not represented.

While the earliest practical applications of electricity had been in the field of telegraphy, the next development was lighting. At the Centennial a few arc lamps run from dynamos were among the exhibits from France. These were shown, not as curiosities, like those exhibited at Paris in 1867 and in New York shortly after that, but as a commercial system. They had been introduced in that country in the winter of 1874–75 for lighting shops and factories, but were still a novelty in spite of the fact that they had been installed in lighthouses several years before that date.[2] They almost immediately came into use in America, though their general introduction was delayed because at first a separate dynamo was required for every lamp. This difficulty was speedily overcome, however; in Europe by the development of the multiple circuit system served by a single generator, and in America by arranging the lamps in series on the same circuit,

[1] Great Britain, *Reports on the Philadelphia International Exhibition*, I, 271–272; *Cf.* U. S. Centennial Commission, *Reports and Awards*, VII, Group XXV, 13–27; U. S. Commissioners to the Paris Exposition of 1889, *Reports*, IV, 10–12; American Iron and Steel Association, *Bulletin*, XVIII, 219, Aug. 27, 1884.

[2] U. S. Commissioners to the Paris Exposition of 1889, *Reports*, IV, 52; National Association of Wool Manufacturers, *Bulletin*, VII, 232, July 1877; U. S. Bureau of the Census, *Electric Light and Power Stations, 1902*, 88.

which was rendered possible by the inventions of Charles S. Brush, of Cleveland, Ohio, and by others protected under the Thomson-Houston patents issued in 1878 and 1879.[3] Incidentally it was an American dynamo that supplied current to the arc lamps exhibited at the Centennial Exposition in Philadelphia, and if this country is not to be credited with priority of invention in this field, it contributed many of the pioneer improvements.[4]

At the Paris Exposition of 1889 the United States was credited with showing more distinct systems of lighting than all the other countries together. By that date America appears to have taken the lead in the perfection of electrical accessories and in the mechanical and administrative organization of services for supplying electricity to a wide range of customers. Among the novelties exhibited was apparatus for electric welding, invented by Professor Elihu Thompson, of Boston, which was regarded as "one of the very few recent developments of an important character in an entirely new direction."[5]

More than ten years before this, immediately after Charles F. Brush perfected his system of operating lights in series on the same circuit in 1878, electrical illumination was introduced in the textile mills of Rhode Island, and the following year the first central lighting station in America, also using this system, was installed at San Francisco.[6] In 1880 the American Electrical Company, which afterward became the Thomson-Houston Company and the principal promotor of this form of lighting in America, was organized and began business at New Britain, Connecticut. Arc lamps were best adapted to illuminating large spaces, and during the first years after their introduction for street lighting were often placed in groups on high masts or towers.[7]

Another and even more important line of development began in 1878 when Thomas Edison resumed his earlier experiments with incandescent lamps. These resulted the next year in a lamp having a platinum burner but requiring an absolutely uniform current to work successfully. Finally, in the autumn of 1879, he resolved the difficulties of the problem to which he had addressed himself by employing a carbon filament of high resistance in a vacuum, served by a low tension current. His series of patents, beginning in January 1880, covered a full and complete system of generating and distributing electric current for light, heat and power; and the Edison Electric Light Company, which had been organized in 1878 while the early experiments were still in progress, opened a business office in New York

[3] U. S. Commissioners to the Paris Exposition of 1889, *Reports*, IV, 52–53; Eleventh Census, *Report on Manufactures, Selected Industries*, 239; *Engineering Magazine*, VII, 703–705, Aug. 1894.

[4] U. S. Bureau of the Census, *Electric Light and Power Stations, 1902*, 90.

[5] U. S. Commissioners to the Paris Exposition of 1889, *Reports*, IV, 90.

[6] New England Cotton Manufacturers' Association, *Proceedings, Oct. 25, 1882*, 38 and 42; Eleventh Census, *Report on Manufactures, Selected Industries*, 239.

[7] American Iron and Steel Association, *Bulletin*, XV, 17, Jan. 19 and 26, 1881; XV, 106, Apr. 27, 1881.

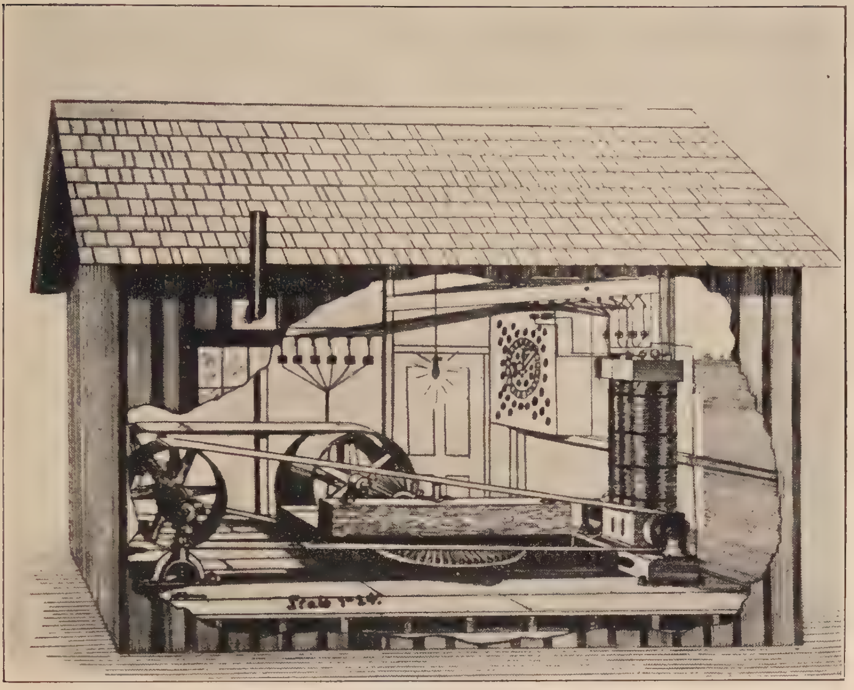

FIG. 1.—First Central Lighting Station in America
(Appleton, Wisconsin, 1882)

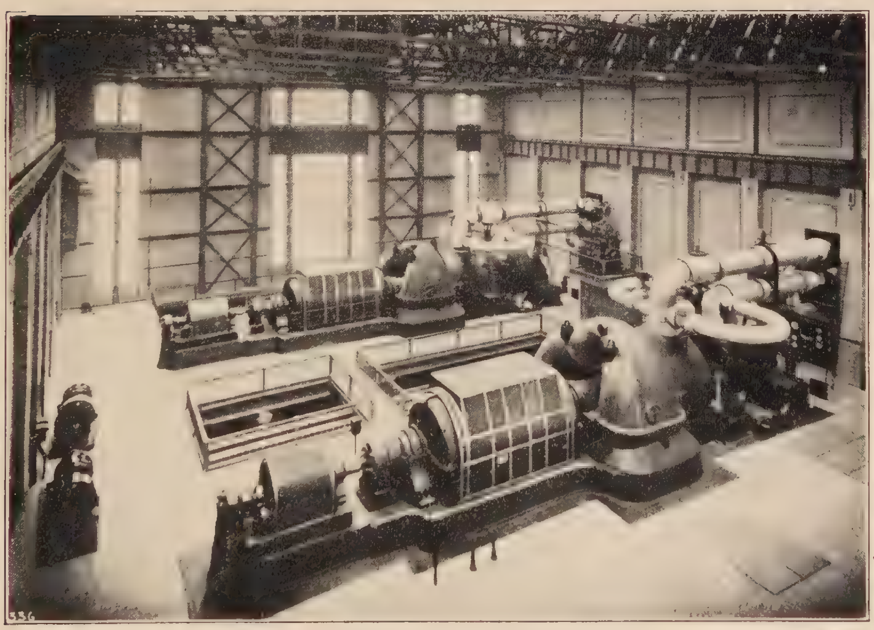

FIG. 2.—Modern Electric Central Station
(Each unit 45,000 kw.)

Courtesy General Electric Company

in 1881.[8] The history of the introduction of incandescent lighting—first on steamers, including the ill-fated *Jeannette*, which sailed for the Arctic in 1879, then in manufacturing establishments, hotels and theaters—is very brief. The first central station went into service at Appleton, Wisconsin, in August 1882 with a dynamo run by water power, and had a capacity of between 200 and 300 lights. Almost simultaneously the New York station was opened with some 50 miles of conductors placed underground.[9]

THE TELEPHONE

Another remarkable invention of this period was the telephone, which was exhibited in 1876 at the Centennial Exposition, where it was considered by the judges "the greatest marvel hitherto achieved by the telegraph." Already audible speech had been transmitted by it for 300 miles.[10] Alexander Graham Bell, the inventor, had received a patent for this instrument the previous March, and the following year organized a stock company to introduce it commercially. At the instance of one of his associates and financial backers, who was attorney for the Gordon-McKay Shoe Machinery Company, the new enterprise adopted the policy successfully followed by that corporation, of leasing its instruments instead of selling them outright—in other words, of selling a service instead of a machine. This logically resulted in the organization of interrelated regional corporations to supply this service to subscribers within definite districts, as occurred a few years later in the distribution of electric light and power.[11]

ELECTRIC TRACTION

Close on the heels of these inventions came electric traction, in which Germany was the pioneer. In 1884, three years after that country inaugurated its first line, an experimental electric street railway operating one car was built at Cleveland. The next year a third-rail system was in use on a suburban branch line of the Baltimore Union Passenger Railway Company. The first overhead trolley road, and the oldest in continuous operation in the United States, ran its first cars at Binghamton, New York, in February 1886, and two years later a greatly improved system of this type, operating 20 cars over 13 miles of track, was installed at Richmond. In 1887 there were said to be thirteen electric lines in the country, and cities as remote from each other as Baltimore and Los Angeles, and Montgomery, Alabama, and Windsor, Canada, had adopted this form of traction.[12]

[8] *Cf.* T. A. Edison and Charles T. Porter, *Description of the Edison Steam Dynamo*, in American Society of Mechanical Engineers, *Transactions*, III, 218–227.

[9] Eleventh Census, *Report on Manufactures Selected Industries*, 240–241; *Commercial and Financial Chronicle*, XXVII, 408, Oct. 19, 1878; *Cassier's Magazine*, X, 57–62, May 1896; U. S. Bureau of the Census, *Electric Light and Power Stations, 1902*, pp. 92–96.

[10] U. S. Centennial Commission, *Reports and Awards*, VII, Group XXV, 21; Depew, *One Hundred Years of American Commerce*, I, 134.

[11] *Bell Telephone Quarterly*, II, 135–152, July 1923.

[12] Eleventh Census, *Report on Manufactures, Selected Industries*, 241–242; Depew, *One Hundred Years of American Commerce*, I, 143–144; II, 380; American Iron and Steel Association, *Bulletin*, XVIII, 229, Sept. 3 and 10, 1884; XXI, 317, Nov. 16, 1887; U. S. Bureau of the Census, *Street and Electric Railways, 1902*, 161–168.

About 1850 a joint stock company at Providence, Rhode Island, succeeded in turning the lathes in a machine shop by electricity conducted to motors through wires from a generator driven by a steam engine.[13] Nearly three decades elapsed before this principle was put to commercial use. But so rapid was progress following that date that in 1888, only ten years after electricity began to be made for sale, there were more than 192,000 arc lights and 1,700,000 incandescent lights in use in the United States; 34 electric railways were operating 223 cars; 49 more roads were under construction, and capital was being invested in providing electric services of one kind or another to the amount of over $80,000,000 annually.[14]

TRANSMISSION AND POWER

The next step toward extending the use of electricity was to improve methods of transmission, so that powerful currents could be conveyed economically over long distances. It was not until the close of the period that we are now describing that this problem approached practical solution. In 1889 elevators and machinery at Lowell were operated with an arc-light current carried 20 miles.[15] In 1891 current was transmitted in Germany 108 miles from the Falls of Lauffen to the International Electrical Exposition at Frankfurt on the Main, with a loss of only one-fourth the original energy.[16] This achievement not only demonstrated the practicability of delivering electricity economically over long distances, and thus the possibility of hydro-electric power development on a large scale, but it also settled a controversy, in which rival capitalists as well as inventors and scientists were at that time engaged, as to the respective merits of the direct and the alternating current systems. The alternating current was employed in Germany and was adopted by the Niagara Falls Power and Construction Company, which was inaugurating its great enterprise at this time.[17]

Hitherto electric driven machinery had been in its commercial infancy, awaiting the solution of the transmission problem and numerous other questions, partly technical and partly economic—such as the replacement of existing power equipment. In 1882 the first electric elevator was placed in service in a cotton mill, and in general electricity was used in textile mills to move materials before it was used to drive looms and spinning frames.[18] Before 1889 machine tools were operated by small motors,

[13] New England Cotton Manufacturers Association, *Proceedings of the Sixth Annual Meeting, April 19, 1871*, 32–33 (this article contains a remarkably accurate prediction); *Cf.* Letter written by A. L. Holley, in Nov. 1851, Professor Page's magnetic engine "is put as capable of improvement as the steam engine—and more so," in American Society of Mechanical Engineers, *Transactions*, IV, 44.

[14] American Iron and Steel Association, *Bulletin*, XXII, 293, Sept. 26, 1888.

[15] New England Cotton Manufacturers Association, *Proceedings, April 1889*, 54–55.

[16] *Frankfurter Zeitung Technisches Blatt*, VII, 97, Apr. 24, 1925; American Iron and Steel Association, *Bulletin*, XXVI, 41, Feb. 17, 1892.

[17] Michael Pupil in *Scribner's Magazine*, LXIV, 719, Sept. 1923.

[18] New England Cotton Manufacturers Association, *Proceedings, Oct. 1892*, 44; *Cf. Cassier's Magazine*, IV, 181, July 1893.

taking their current from an arc-light circuit.[19] What was characterized as the first case where electricity was "used in the Western Pennsylvania industrial world for the operation of machinery" was its application to a 100-ton traveling crane, at the Edgar Thomson Steel Works in 1893.[20] By the latter year, when the Electrical Congress was held at the Worlds Fair in Chicago, the pioneer stage of the industry in practically all its present phases except wireless communication was well over. Fifteen years had seen the infant become a man.

ORGANIZATION

In the electrical industry, as in the manufacture of rubber, sewing machines, shoe machinery and a number of other products that owed their commercial success to single inventions or groups of inventions, organizations crystallized around patent rights. Companies were usually designated by the names of inventors. The American manufacture of electrical machinery and its accessories speedily fell into the hands of two or three such groups. In 1878, the Edison Electric Light Company filed its certificate of incorporation in New York City, stating its object to be the production of light, heat and power by means of electricity. Its capital was $300,000 and Thomas Edison was among the incorporators. This company controlled the most important Edison patents and its history for the ten years following its formation is representative of the history of the whole electrical industry. Its business was primarily illumination. With its encouragement, companies were organized in the larger cities, more or less under its control or with its financial participation, to supply light to municipalities and private users. At the same time the Company devoted a part of its resources to defending, developing and perfecting its patents. In 1888 a single lamp improvement added 50 per cent to the quantity of illumination obtained from a unit of electricity.

During this first decade of its existence, the Company sold or established nearly 1,500 lighting plants or central stations operating approximately 730,000 lamps. Some of its subsidiary companies were abroad, and one of these, grown great and independent as the Allgemeine Elektrizitäts-Gesellschaft, ultimately became its most powerful international competitor.[21] The parent Company was combined in 1889 with a new organization, the Edison General Electric Company, still retaining its identity. The latter was an amalgamation or absorption of seven existing corporations engaged in different branches of the electrical business, which divided the country into eight geographical districts under local managers.[22]

[19] New England Cotton Manufacturers Association, *Proceedings, April 1889*, 55.

[20] American Iron and Steel Association, *Bulletin*, XXVII, 189, Apr. 21, 1893; *Boston Journal of Commerce*, XXXVIII, 110, May 23, 1891; XXXVIII, 222, July 11, 1891.

[21] *Commercial and Financial Chronicle*, XXVII, 408, Oct. 19, 1878; XLVII, 624, Nov. 24, 1888; *Frankfurter Zeitung Technisches Blatt*, VII, 97, Apr. 24, 1925.

[22] *Commercial and Financial Chronicle*, XLVIII, 609, May 11, 1889; L, 244, Feb. 15, 1890; LII, 163–164, Jan. 24, 1891.

During this period the Edison companies, like other electrical companies, were engaged in almost constant litigation over patents; and in 1891 they gained a favorable court decision establishing their exclusive rights to the carbon filament incandescent lamp against the United States Electric Lighting Company, which belonged to the Westinghouse-Thomson-Houston group.[23] The latter combination embraced two large companies. The Westinghouse people, with headquarters at Pittsburgh, were originally associated with smaller incandescent lamp companies operating under patents contested by the Edison interests. In 1889 this group had equipped some 1,100 plants and central stations in the United States with an aggregate capacity of more than 1,000,000 Sawyer-Man lamps. The Thomson-Houston Company had been organized in 1883 at Boston, and its principal factory was at Lynn. The two companies often worked in friendly alliance, which led to rumors of a closer relationship, but they were not consolidated except to the extent of an agreement for the joint use of certain patents. The Westinghouse Company ultimately absorbed the United States Electric Light Company and the Consolidated Electric Light Company whose works it had previously leased, and in 1892 it was operating three factories, manufacturing mainly generators and motors for traction companies and mines.[24] The Thomson-Houston Company was more largely engaged in the traction business, though it manufactured arc lamps extensively, and apparently had some advantage over the Edison group in this special field of illumination. In 1890 it had under contract 175 electric railways operating 2,000 cars, and 500 incandescent companies operating more than half a million lights, besides controlling about 85,000 arc lamps. Its business had risen from less than half a million dollars in 1883, to more than $10,500,000 at the Boston office alone seven years later. Branches not in existence the previous year added about one-fourth to the later total. The Company's operations were world wide, covering Europe, Asia, Australia, Central and South America, and the West Indies.[25]

GENERAL ELECTRIC COMPANY

In 1892 the present General Electric Company, with a capital of $50,000,000 virtually the creation of a decade, succeeded the Edison General Electric Company and the Thomson-Houston Company. At this time the Lynn plant of the latter corporation occupied a site of 23 acres and 20 buildings, and employed 3,800 workers. The Edison General Electric Company's plant at Schenectady covered 29 acres and also had 3,800 employes, in addition to which other factories and lamp works employing some 2,300 hands were operated directly by this Company.[26]

[23] The records of this case contain a full history of the invention: *Commercial and Financial Chronicle*, LIII, 95, July 18, 1891.

[24] *Commercial and Financial Chronicle*, XLVIII, 428, Mar. 30, 1889; LII, 322, Feb. 21, 1891; LIII, 846, Dec. 5, 1891; American Iron and Steel Association, *Bulletin*, XXVII, 130, May 3, 1893.

[25] *Commercial and Financial Chronicle*, LI, 777, Dec. 6, 1890; LII, 607–608, Apr. 18, 1891.

[26] *Commercial and Financial Chronicle*, LIV, 1050–1051, June 25, 1892.

In the first annual report of the General Electric Company, the number of central stations using the Edison and Thomson-Houston apparatus was given as 1,277, supplying 2,500,000 incandescent and 110,000 arc lamps. Between 1891 and 1893 the number of traction companies employing General Electric equipment had increased from 151 to 435; the number of miles of road in actual operation had grown from 1,252 to 4,927; and the number of cars in use had risen from 1,578 to 8,386. An interesting feature of electrical development at the close of the period we are describing was the notable increase in the size of individual generators and motors. The largest manufactured on February 1, 1892, was of 275 horsepower. A year later a number of generators of 2,000 horsepower were being built. Where a year previously the largest number of incandescent lamps supplied from one dynamo had been 2,000, generators were under construction with a capacity of 12,000 lamps.

The Company's engineers were directing their attention especially to the production of electrical locomotives both for mines and for railroad use. Orders for several had already been received, including two of 1,600 horsepower each, which were nearly completed. Equipment for the elevated electric line at the World's Fair had just been finished at the Schenectady works. The reports of this Company almost invariably contain allusions to patent litigation and decisions. It controlled the inventions of Edison, Thomson, Brush, Sprague, Van Depoele, Rice, Bentley, Knight and other pioneers whose discoveries and improvements had within a few years converted the electrical business from laboratory research plus a single practical application of first importance, the telegraph, into one of the foremost industries of the country.[27]

[27] *Commercial and Financial Chronicle*, LVI, 625–626, Apr. 15, 1893; *Boston Journal of Commerce*, XXXVIII, 30, Apr. 18, 1891; XXXVIII, 190, June 27, 1891; XXXVIII, 238, July 18, 1891; XXXVIII, 334, Aug. 29, 1891; *Engineering Magazine*, VII, 539–555, July 1894.

CHAPTER XXXIII

GENERAL ASPECTS OF THE COTTON MANUFACTURE

PRODUCTION AND CONSUMPTION OF RAW COTTON

The twenty years ending with 1893 cover the period of greatest expansion that the cotton industry has ever experienced. It is not so dramatic an era as that which followed the invention of the cotton gin and automatic spinning, but it witnessed a larger absolute increase in the consumption of cotton than any other equal interval in our history. During the early seventies, the cotton crop of the United States had about recovered the position it held during the most favorable years immediately preceding the Civil War. We raised 4,000,000 bales more or less per annum. By the corresponding years two decades later, our crop had doubled, and in 1892 and 1895 it exceeded 9,000,000 bales. Domestic consumption increased in nearly equal ratio. Between the middle seventies and the middle nineties the world's annual cotton crop rose from about 7,000,000 bales to between 12,000,000 and 13,000,000 bales, approximately two-thirds of which was raised in the United States. American mills consumed rather less than a quarter of the total quantity manufactured in all countries.[1]

This rapid increase in the raw material supply occurred in the face of steadily falling prices. The average New York quotation for middling uplands declined from 19⅛ cents in 1873 to 8 cents in 1893. While the average price never fell below 10 cents prior to 1885 it reached that quotation in only two years during the following decade. Between 1872 and 1894 the price of general commodities fell 50 per cent, and of wheat 60 per cent; but the price of cotton fell 70 per cent. Furthermore, this decline was accompanied by a steady improvement in the quality of fiber, in the grading, and to a smaller extent in the packing of the cotton received from American plantations.[2]

While there was an increase in the area planted in cotton in the South Atlantic and Gulf states, the most notable expansion occurred in the prairie country west of the Mississippi, mainly in Texas and Oklahoma. The more general use of labor-saving machinery made possible extensive methods

[1] U. S. Department of Commerce and Labor, *Statistical Record of the Progress of the United States, 1800–1907*, 28, 32; *Commercial and Financial Chronicle*, XXXIX, 282–283, Sept. 13, 1884; LIX, 633–634, Oct. 13, 1894.

[2] *Commercial and Financial Chronicle*, XLV, 870–872, Dec. 31, 1887; LXIII, 435, Sept. 12, 1896; U. S. Industrial Commission, *Reports*, VI, 143.

of cultivation in these regions not customary in the older plantation districts where colored labor was mainly employed.

Coincident with the period of western expansion, though not entirely due to it, was the increase in the amount of cotton received by northern manufacturers and shippers by overland routes. In the middle eighties, however, the southern ports seemed about to regain their oldtime ascendancy as shipping points for this staple. The check to the overland movement of cotton which occurred at that time was attributed partly to the effect of the Interstate Commerce Law.[3] It was due in part, no doubt, to increased railway facilities to the Southern ports themselves. But the absolute quantity of cotton shipped overland, where it constituted to some extent a backload balancing northern manufactures shipped to the South, nevertheless continued to increase.

Already statistics of the raw-cotton trade began to be affected by the enlarged consumption in the immediate vicinity of the fields where it was grown. In 1875 the South consumed one bale of cotton for every eight taken by the rest of the country. Fifteen years later its mills used one bale for every 2.3 bales spun by its Northern competitors. By the close of the century 1,500,000 bales were spun in the South and not quite 2,000,000 bales in the North. Five years later the South was far ahead in quantity of cotton used, though of course not in value of goods produced.[4]

Meanwhile the proportion of all the cotton manufactured in the world spun by American spindles was gradually increasing. The factories of Europe were simultaneously gaining upon those of Great Britain. During the six years preceding 1873, the United States manufactured nearly one-fifth of all the cotton spun by machinery. During the six years ending with 1884, it spun well toward one-quarter of the world's supply. This proportion remained fairly constant during the remainder of the decade ending with 1890, but the approximately stationary position of the United States was due to the increase of cotton spinning in Asia, especially in British India, the consumption of whose spindles rose from 262,000 bales in 1879 to about 750,000 bales ten years subsequently.[5]

Late in the decade ending with 1890, the rapid expansion of cotton spinning throughout the world was a source of more uneasiness than congratulation for manufacturers. Constant fear was expressed that the production of yarn and fabrics would outstrip the market. The world's spindles, without including those in Asia, used more than 11,000,000 bales of cotton annually. Twenty years earlier the total consumption was but 5,000,000 bales. There had been an increase of 120 per cent in the use of cotton in

[3] *Commercial and Financial Chronicle*, LI, 322–323, Sept. 13, 1890; LX, 64, Jan. 12, 1895; U. S. Industrial Commission, *Reports*, VI, 169–170.

[4] *Cf.* Scherer, *Cotton as a World Power*, 341; *Commercial and Financial Chronicle*, XXI, 292, Sept. 25, 1875; LI, 330, Sept. 13, 1890.

[5] *Commercial and Financial Chronicle*, XXXIX, 282–283, Sept. 13, 1884; XLVII, 516, Nov. 3, 1888; LI, 324–325, Sept. 13, 1890. For earlier comparisons see New England Cotton Manufacturers Association, *Proceedings*, Oct. 31, 1877, pp. 65–68.

factories within 21 years and an increase of nearly 30 per cent within five years. Manufacturers were asking when this growth would receive a sudden check. This did not come, however, until the general depression which ensued three years later.

Since American mills were spinning increasingly finer yarns and producing more specialties and high-grade fabrics, the demand for longer stapled cotton enlarged. This occurred in spite of the fact that mechanical improvements and the larger use of sizing made it possible to spin short staples into finer yarns than formerly. In order to meet this growing demand, the cultivation of sea-island cotton was tried at several places in Florida, Georgia and elsewhere with sufficient success to increase the area of this crop. During the era of low-cotton prices following 1890, the sea-island cotton growers of South Carolina attempted to combine to prevent the shipment of their seed to other states, but it was found impracticable to enforce such a policy.[6]

The struggle of the South to restore its depleted capital after the war, the change in its labor system and the indifference that often attends the production of monopoly goods, delayed improvements in preparing cotton for shipment, and indeed what would have been profitable economics to cotton raisers, until about the time of the Atlanta Exposition of 1881.[7] Immediately after that event, which was of great educational value to southern planters and marked the dawn of a new psychological as well as industrial era in that section, very rapid progress was made in methods of ginning, handling and baling. This was due partly to the enlightened policy of English consumers, who erected model gins at several points in the cotton states.[8] About the same time roller gins recovered favor with the growing demand for a longer staple.[9] Among the notable improvements of this period were the employment of suction pipes to unload wagons, which became common after 1885, and the introduction of the feeder and condenser, which deliver the ginned cotton in a bat instead of a tumbled mass. Steam cotton presses and central gins replaced in most parts of the South the primitive plantation gins that had been common during the slavery period. The rising cost of labor as well as more exacting buying standards helped along this progress.[10]

TECHNICAL PROGRESS

Among the more important technical advances in cotton mills during this period of rapid expansion, which in itself favored the speedy adoption

[6] *Manufacturers' Record*, xx, 11, Oct. 10, 1891; xx, 7, Oct. 17, 1891; *Boston Journal of Commerce*, xxxviii, 344, Sept. 5, 1891; xli, 152, Dec. 10, 1892.

[7] New England Cotton Manufacturers' Association, *Proceedings*, Oct. 31, 1877, 45; Apr. 26, 1882, pp. 54–55.

[8] Tenth Census, *Report on Manufactures*, 944–946.

[9] New England Cotton Manufacturers' Association, *Proceedings*, Apr. 27, 1881, p. 16.

[10] Tompkins, *History of Mecklinburg County*, i, 181; *Cf. The Textile Record*, i, 49, Nov. 1880; *Manufacturers' Record*, viii, 335, Oct. 24, 1885.

of new machinery and methods,[11] was the introduction of the revolving flat card, which was brought from England and was extensively used in the United States before 1887, when it was first mainufactured in this country. This invention reduced waste, saved time and enabled a poorer staple to be profitably carded. By 1890 cotton combing machines were fast coming into use. Numerous other improvements were made in preparation machinery. These were mostly of British origin, since English mills used poorer staples upon an average and spun finer yarns than those of America, and consequently derived more benefit from devices that facilitated this stage of the manufacturing process.[12]

The most important advances at this time, however, were in spinning machinery, and were mainly of American origin. Up to 1870 ring spindles rotated about 4,500 times a minute. Twenty years later this speed had been practically doubled, the quantity of yarn made by a spindle had increased by fully one-half, and the improved spindle could be operated with less power than the older type. This was accomplished by a series of devices to prevent vibration when the spindle was rotating at a high rate of speed.[13] By 1870 and for some little time thereafter, mules were used almost exclusively for spinning finer counts, especially of softer yarns, and filling. Partly because of the improvement in the frame spindle already mentioned, and partly on account of labor troubles involving the strongly organized male mule-spinners, most of whom came from England and brought their unions with them from that country, some mills making fine counts installed frame spindles exclusively and proved that they could be used successfully for making yarns which previously had been spun only by mules.[14]

These revolutionary improvements in the frame spindle stimulated the manufacturers of mules to improve their machinery. They speeded up their spindles by adopting the same devices to prevent vibration that had proved so successful in spinning frames. By these and other betterments they made it possible to operate mules faster than formerly, and to equalize the relative efficiency of the two systems of spinning. None the less, after a period during which mules seemed to be supplanting the spinning frames which had been typical of American mills before the Civil War, the process was reversed and frame spindles again increased more rapidly than their

[11] *Cf.* Chapman, *The Lancashire Cotton Industry*, 31, note 5.

[12] Copeland, *The Cotton Manufacturing Industry in the United States*, 60–61, 64; New England Cotton Manufacturers' Association, *Proceedings*, Oct. 27, 1880, 24–27; Oct. 29, 1884, 56, 62, 76–77; Oct. 28, 1885, p. 19; *Boston Journal of Commerce*, XXVII, 154, Jan. 30, 1886; XXX, 251, Oct. 8, 1887; XXXVIII, 88, May 16, 1891; XXXVIII, 283, Aug. 8, 1891.

[13] New England Cotton Manufacturers' Association, *Proceedings*, Apr. 29, 1891, 23, 43; Copeland, *The Cotton Manufacturing Industry in the United States*, 66–67; U. S. Industrial Commission, *Reports*, XIV, 460–461.

[14] *Textile Record*, V, 73, Mar. 1884; *Boston Journal of Commerce*, July 18, 1885; Webber, *Manual of Power*, 72; New England Cotton Manufacturers' Association, *Proceedings*, Oct. 26, 1881, 7–9. No. 160 yarns were spun at the Centennial Exposition on ring spindles making 7500 revolutions a minute. Great Britain, *Reports on the Philadelphia International Exhibition*, III, 523.

competitors. In 1870 the number of frame spindles and mule spindles in the United States was approximately equal, there being 3,695,000 of the former and 3,438,000 of the latter. Twenty years later there were 8,825,000 frame spindles and 5,364,000 mule spindles in the country. The increase of the former had been nearly 137 per cent and that of the latter 56 per cent.[15] No corresponding notable improvements were made in weaving machinery, although the output of plain looms was estimated to have increased by one-fifth between 1860 and 1880; but experiments were in progress during the eighties that resulted in the radical advances associated with the names of Northrop and Draper in the following decade.[16]

Electricity became a handmaid of textile manufacturing during these twenty years. After 1880 electric lights rapidly replaced gas or petroleum for mill illumination. We have recorded elsewhere the introduction of electric motors in cotton mills. Another and even earlier application of electricity was to stop motions. The first of these inventions to attract attention was exhibited at the Centennial Exposition in 1876. It had not then been perfected, but was speedily improved and by 1883 was in common use.[17]

Reliable measurements of technical progress in the cotton industry, as exhibited in output records per employe or per unit of machinery, are not easy to obtain. In 1876 it was estimated, on a basis of the mill records of two important New England corporations, that the product per operative had increased more than threefold since 1838.[18] A comparison of a different character made in 1891 indicated that at that date a 30,000-spindle mill, working on print cloths, would produce about as much as a 40,000-spindle mill twenty years earlier.[19]

Mill design was assuming the character familiar today. Before 1880 insurance companies had begun to preach the one-story mill building with monitor roofs and machinery driven by shafting beneath the floor, as safest for employes and most economical to heat, light and maintain. Heavier machinery and higher speeds were constantly presenting new problems for construction engineers.[20] To be sure new mills four and five stories high were erected, as they continue to be today.[21] But this was before steel and reënforced concrete were as common structural materials as at present; and wherever land was cheap and abundant lower buildings than formerly were the rule. This was particularly true in the South. Early American textile mills, which were usually run by water wheels of limited power, and financed

[15] Copeland, *The Cotton Manufacturing Industry in the United States*, 67–74; Eleventh Census, *Report on Manufactures, Selected Industries*, 168–170.

[16] Tenth Census, *Report on Manufactures*, 584.

[17] *Textile Record*, II, 207, Aug. 1881.

[18] National Association of Wool Manufacturers', *Bulletin*, IX, 42–43, Mar. 1879; New England Cotton Manufacturers' Association, *Proceedings*, Oct. 29, 1879, 88.

[19] New England Cotton Manufacturers' Association, *Proceedings, Oct. 28, 1891*, 55–56; *cf. id.*, Apr. 29, 1885, 73.

[20] New England Cotton Manufacturers' Association, *Proceedings, Apr. 30, 1879*, 69.

[21] *E.g., The Textile Record*, V, 50, Feb. 1884.

with limited capital, were hardly larger than a prosperous farmer's barn, and like the grist mills that served as their models usually had the power applied at one end. The next stage of progress, in cases where the site permitted, was to build the mill across the stream and place the wheel in the center, with a line of shafting in either direction 100 to 150 feet long, the extreme length that could be operated satisfactorily at that time. This general arrangement was repeated when steam began to supplant or supplement water power, the engine and boiler being placed in a separate engine house or in an L at the center of the main mill building in order to keep the length of shafting as short as possible. For the same reason, a mill 300 or 400 feet long and several stories high was preferable to a longer mill of less elevation. With the introduction of turbine water wheels and high-power steam engines, and the perfection of transmission by shafting, and especially by electricity, these restrictions on ground area ceased to influence mill design, and the long low modern spinning room and weaving shed became mechanically possible. In 1892 a single line of shafting at Manchester, New Hampshire, drove nearly 33,000 spindles, besides 20 warpers and 2 slashers.[22]

Between 1880 and 1890 the cycle of expansion that began shortly after the Civil War seemed to have culminated. During that decade 600,000 new spindles were installed in American cotton mills each year. Under the stimulus of this growth inventions that increased the output of labor were seized upon eagerly, and during the constant remodeling and enlargement of plants antiquated machinery was speedily scrapped. This resulted in a marked increase in the consumption of cotton per spindle, despite the fact that finer yarns were spun than formerly, the annual average rising from 70.43 pounds in 1880 to 78.79 pounds ten years later.[23]

An era of labor unrest in the middle eighties disturbed the tranquillity of cotton manufacturers, but apparently had little ultimate effect on the annual product of their mills. In 1884 the Fall River companies made a general reduction of 20 per cent in the wages of spinners and weavers, and the old rate was not restored until nearly four years later. Several strikes occurred, but none of them involved the entire cotton industry or formed a sensational or significant chapter in the labor annals of the period.[24] It was not until 1878 that the first national union of textile workers—that of the cotton spinners—was organized.[25]

COTTON FABRICS

A growing differentiation of products and increased attention to finer goods characterized this period; but in 1890 by far the greater part of the yarns and fabrics made in America were still of coarse or medium grade.

[22] New England Cotton Manufacturers' Association, *Proceedings, Apr. 27, 1892*, 45–46.
[23] Eleventh Census, *Report on Manufactures, Selected Industries*, 169, 170, 184.
[24] *Commercial and Financial Chronicle*, XLIX, 326, Sept. 14, 1889.
[25] Commons, *History of Labor in the United States*, II, 313.

It was said in 1880 that one hundred different makes of sewing thread were manufactured in the United States. Nevertheless much thread was imported in an unfinished condition and twisted and spooled in America. To the two large British firms that had already erected factories in this country a third was added in 1883, when the Clark Mile-end Company built its first mills in New Jersey. By 1890 nearly 14,000,000 pounds of thread, valued at well toward $12,000,000, were spun annually.[26]

In 1882 the Arlington Company of Lawrence, which had hitherto imported from Europe most of its fine yarns for weaving, began to spin them not only for its own use but also for thread manufacturers, hosiery mills, lace makers and other consumers with whom quality was the great desideratum.[27] Simultaneously the Globe Mills of Fall River erected a new plant to supply the same market, and were so successful that in 1887 the Company built an additional mill containing 40,000 spindles, expressly to spin fine counts from sixties to one-hundreds. A few American establishments had been producing high counts for twenty or thirty years, but mostly for consumption within their own establishments. Devices for maintaining artificial humidity in the air of spinning and weaving rooms facilitated the production of finer fabrics. When the Globe Mills began to produce regularly for the general market a cotton yarn as fine as No. 100, it was hailed as a landmark in the history of the American textile industry. Within a year the price of these yarns, which hitherto had been imported, fell from $1.50 to $1.10 a pound.[28]

Not only the relatively greater fineness of the cotton fabrics made in America, but also other qualities associated with a higher degree of textile craftsmanship, testified to the increasing attention given to spinning high number yarns. At the Centennial Exhibition the cotton goods displayed by American manufacturers were reported to be so nearly on an equality with those exhibited from Great Britain and Europe "that no one could lay claim to any marked degree of superiority."[29] But this judgment was based upon a comparison of a broad range of domestic fabrics with less complete exhibits from abroad, and also, perhaps, upon a balancing of compensating excellencies in American and foreign goods respectively. The cotton manufacture of the United States continued to be characterized by the substantial qualities that had distinguished them since the inauguration of the industry. They were made as a rule from better cotton and with far less sizing than those woven in Great Britain. Standard American fabrics were sold under well-known mill brands, principally in the home market, where the buyer's good will was an important asset for the producer, while many British and Continental factories made goods more or

[26] Eleventh Census, *Report on Manufactures, Selected Industries*, 181, 183; American Iron and Steel Association, *Bulletin*, XIV, 269, Nov. 3, 1880.

[27] *American Textile Manufacturer*, II, 39, Mar. 1882.

[28] New England Cotton Manufacturers' Association, *Proceedings, Oct. 29, 1879*, 116–117; American Cotton Manufacturers' Association, *Proceedings, May 20-21, 1908*, 175–178.

[29] U. S. Centennial Commission, *Reports and Awards*, V, Group VIII, 7.

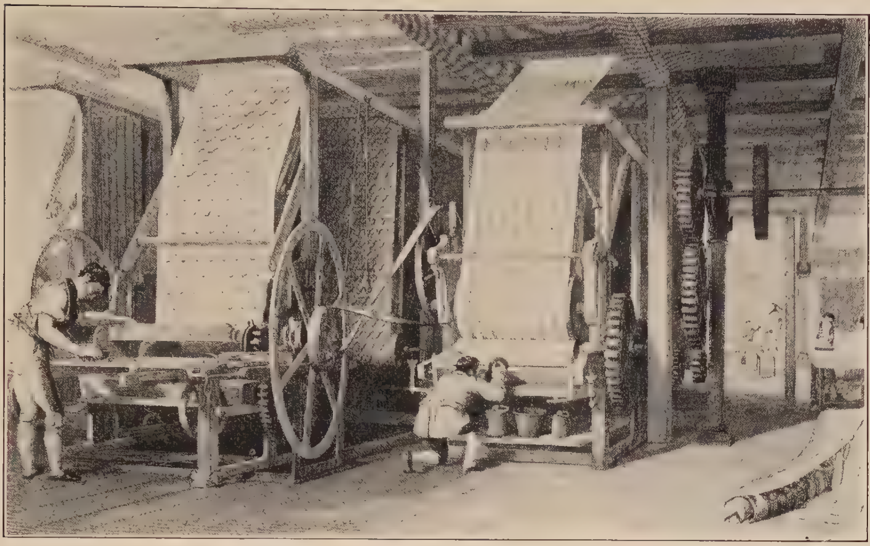

FIG. 1.—Cotton Printing in the Thirties

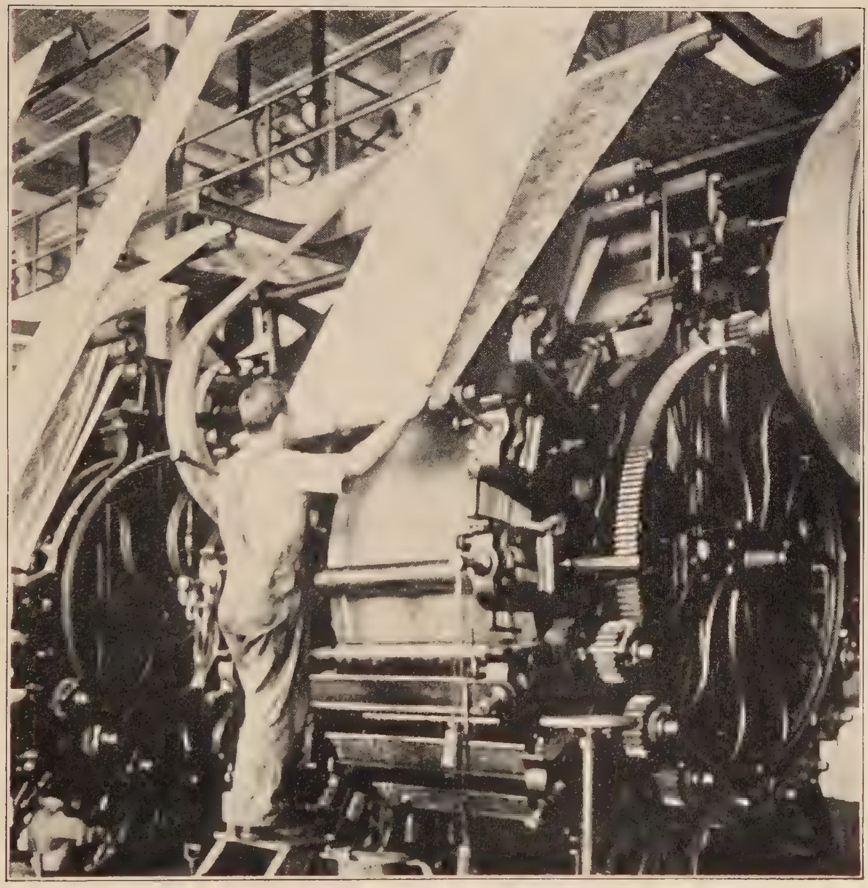

FIG. 2.—Cotton Printing Today

less anonymously for the export trade.[30] As a consequence of these conditions appearance was a more important element in the value of foreign than of domestic fabrics. When appearance was joined to the substantial quality that constituted the distinctive merit of American goods, in a fabric produced in Great Britain or Europe—and of course this occurred in many cases—the product was intrinsically superior to anything turned out by American mills.

In 1890 sheetings and shirtings were the most important products, both in quantity and value, recorded among our cotton manufactures; but print cloths were a close second and far outdistanced the drills and ginghams that had ranked well toward the head in earlier mill statistics.[31] Prints had always been standard fabrics with the rank and file of the population, but about 1885 they became the vogue in Society, at least in some parts of the country. There was what was called the "calico craze," and for the brief period that such ephemeral vagaries generally last an abnormal activity prevailed in this branch of the cotton goods market. These cloths were now woven entirely from ring spindle yarn by many manufacturers, and in this department of the cotton industry printing and finishing were generally conducted in separate establishments. Nevertheless the organization of this business in America was very different from that in Great Britain. For example a printing machine in this country turned out three times as much as a machine in England, and other features of quantity production prevailed in our mills.[32] Among the cotton fabrics that assumed new importance in the eighties were upholstery goods, the manufacture of which was remarkably centralized in Pennsylvania. The whole value reported in 1890 was $2,070,000 of which all but about $163,000 was credited to that state.[33]

Notwithstanding all that has been said, however, the most striking general fact with regard to the cotton fabrics made in 1890, to quote a contemporary review of the census statistics of this industry, was—

> "the very great preponderance of the goods that may be classed as coarse and medium. The largest single item both in quantity and value consists of plain sheetings and shirtings, followed closely in amount, and at a somewhat greater distance in value, by the print cloths from which plebeian calico was made. Add in the ginghams, cotton flannels, ticking, denims and stripes, and duck and bagging, and we have accounted for almost 80 per cent of the woven goods reported. But while coarse and medium weaves are, and must always be, the staple products, a good increase has occurred in the weaving of fine goods. The progressive growth of the business of spinning yarn for use in other mills—

[30] *The London Times*, quoted in Peck and Earl, *Fall River and its Industries*, 88–89; New England Cotton Manufacturers' Association, *Proceedings, Oct. 29, 1879*, 99–101.

[31] Eleventh Census, *Report of Manufactures, Selected Industries*, 202–203.

[32] New England Cotton Manufacturers' Association, *Proceedings, Oct. 29, 1884*, 68–69; American Iron and Steel Association, *Bulletin*, XIX, 211, Aug. 12, 1885; Eleventh Census, *Report of Manufactures, Selected Industries*, 202, 234; *Boston Journal of Commerce*, XXXVIII, 43, Apr. 25, 1891.

[33] Eleventh Census, *Report on Manufactures, Selected Industries*, 179.

in other words, the division of the manufacture of cloth into two separate industries—is also apparent in the large quantity and value of yarns for sale."[34]

Between 1888 and 1890, when there was an abrupt rise in the price of jute employed for covering cotton bales, an agitation started in the South in favor of using a heavy cotton fabric in its stead. Several establishments, particularly the Lane Mills at New Orleans, and the Maginnis Mills in the same city, were largely engaged in making such a fabric. In order to give it an assured advantage over other materials, the Southern Farmers' Alliance negotiated with the cotton brokers of the United States for a lower tare on bales covered with cotton than upon those covered with jute. And, in fact, cotton baggings were several pounds lighter per bale than jute baggings. It was estimated that by securing an allowance of the true tare, a margin of from 16 cents to 25 cents a bale would exist in favor of the cotton covering. The Exchanges did agree provisionally to give a 5-pound preference to cotton covered bales in their tare allowance. In 1892 sixteen factories in the United States were devoted exclusively to the manufacture of this fabric, of which seven were in the South. They manufactured more than 90,000,000 yards per annum at an approximate price to consumers of a little more than six cents a yard.[35] During this cheap cotton era a heavy cotton duck came into vogue for roofing purposes. Several manufacturing establishments in New England, including the Globe Yarn Mills at Fall River and the Pacific Mills at Lawrence, were roofed with this material.[36]

[34] *Commercial and Financial Chronicle*, LV, 656–658, Oct. 22, 1892.

[35] *Commercial and Financial Chronicle*, XLVII, 388, Sept. 29, 1888; XLVIII, 735, June 1, 1889; XLIX, 212, Aug. 17, 1889; XLIX, 379, Sept. 21, 1889; *Manufacturers' Record*, XXII, 147, Sept. 23, 1892; *cf.*, however, *Boston Journal of Commerce*, XXXIX, 158, Dec. 12, 1891

[36] *Textile Record*, II, 256, Sept. 1881.

CHAPTER XXXIV

STATISTICS AND GEOGRAPHY OF THE COTTON MANUFACTURE

NEW ENGLAND

New England retained its old precedence as the principal seat of the cotton industry during this period, having 77 per cent of all the spindles in the country in 1870, and 76 per cent in 1890.[1] Fall River was our greatest cotton manufacturing city, and except Cohoes every distinctively cotton textile town of first rank was in the New England states. More than a quarter of the cotton spindles in the country—in fact, 29.61 per cent—were in the adjoining counties of Bristol, Massachusetts, and Providence, Rhode Island.[2] Lowell and Lawrence as well as Fall River retained their prominence in this industry and New Bedford became soon after 1880 the third spindle city of the Union.[3] In 1882 Fall River had 1,600,000 spindles; Lowell about 800,000 spindles; and New Bedford 440,000. The next cities in rank were Manchester, New Hampshire, with about 315,000 spindles; Lawrence with 300,000, plus its active woolen industry; Lewiston, Maine, nearly equaling Lawrence, Biddeford in the same state, and Cohoes, New York, which ranked close to Lewiston.

The growth of Fall River as a manufacturing town was one of the spectacular incidents of the history of this period. After the great boom immediately preceding the panic of 1873, the building of cotton mills in that town received a temporary check. A transition to finer goods occurred, accompanied by the consolidation of the industry and the erection of larger mills.[4] In 1875 the town contained 41 factories operating nearly 1,200,000 spindles and over 29,000 looms.[5] The largest mill contained 88,000 spindles but the average number was under 30,000. These establishments continued to be devoted almost entirely to the production of print cloths, which at that time were very profitable. A relatively large amount of English machinery, especially mules and dressers, was employed, although the cards and looms were mainly of American make. By the turn of the decade the town had about 1,500,000 spindles.[6]

[1] Eleventh Census, *Report on Manufactures, Selected Industries*, 186–187.
[2] Twelfth Census, *Reports*, IX, 30.
[3] *The Textile Record*, III, 215, Aug. 1882.
[4] Fenner, *History of Fall River*, 74.
[5] American Iron and Steel Association, *Bulletin*, IX, 297, Oct. 8, 1875.
[6] Peck and Earl, *Fall River and its Industries*, 112; Webber, *Manual of Power*, 72; *The Textile Record*, II, 340, Dec. 1881.

About this time the old Fall River Iron Works, established in 1821, ceased entirely their original business and the property was subdivided among the shareholders of the various textile corporations that the Iron Works Company had promoted and controlled.[7]

In 1883 Fall River operated more than one-seventh of all the spindles in the United States, and produced over three-fifths of all the print cloths manufactured.[8] By 1889 the number of spindles exceeded 2,100,000, a gain of 28 per cent during the decade. This single city then operated 50 per cent more spindles than the entire South, in spite of the remarkable progress of cotton manufacturing in the latter section.[9] The Fall River Iron Works had come into possession of M. C. D. Borden, who succeeded the Spragues of Rhode Island as the cotton king of New England. The advantages that attracted so large a fraction of the fine spinning and weaving industry to this center were its humid climate, its water power, its harbor, and its situation in the midst of what has always been the area of greatest spindle concentration in the United States.[10]

Although the mills along the Merrimac from Lawrence to Manchester, and their sister establishments farther up the New England coast, did not make as rapid progress relatively as those south of Cape Cod, partly because a growing fraction of the market for coarse goods to which they more largely catered was being supplied by Southern mills, the industry made steady progress even there and up to 1890 the number of spindles continued to increase in every New England state except Connecticut.

THE MIDDLE ATLANTIC STATES

West of the Hudson the only cotton spinning city of first rank was Cohoes, where as early as 1876 one giant establishment contained 275,000 spindles, at that time the largest number in a single factory in the United States. These mills, as well as those of New Jersey, where the spinning industry was more firmly established than elsewhere in the North outside of New England, produced relatively large quantities of yarn for knitting and for the manufacture of special fabrics.[11] Newark was our principal thread-making center. Pennsylvania continued to be, as it had been for more than a century, a weaving rather than a spinning state, although it occupied respectable rank also in the latter field. For instance, in 1890, New Jersey operated more than 100 spindles to a loom and Pennsylvania only 31 spindles to a loom. Furthermore, Philadelphia spinners were

[7] Fenner, *History of Fall River*, 63.
[8] American Iron and Steel Association, *Bulletin*, XVII, 269, Sept. 26, 1883.
[9] *Commercial and Financial Chronicle*, L, 363, Mar. 8, 1890.
[10] Young, *American Cotton Industry*, 2–3; Copeland, *The Cotton Manufacturing Industry in the United States*, 29–30; New England Cotton Manufacturers' Association, *Proceedings*, Oct. 30, 1889, 41–43.
[11] American Iron and Steel Association, *Bulletin*, X, 316, Nov. 29, 1876; *Textile Record*, III, 129, May 1882.

especially proficient in making hosiery yarns from cotton carded and spun on woolen machinery.[12]

A group of small cotton mills—with one or two larger establishments—had been in operation at Baltimore and vicinity from the pioneer days of cotton-spinning in America. Several of these mills manufactured duck, for which Baltimore had been famous since the days of the Chesapeake clippers; and about four-fifths of all this fabric made in the United States came from that city and its vicinity. Woodbury, a contiguous suburb, contained well toward half the 160,000 spindles in the state.[13]

THE WEST AND FAR WEST

While the amount of cotton machinery operated in the Northern states west of the Alleghenies, and those beyond the Mississippi, increased slowly during these twenty years, and by 1890 approached 165,000 spindles, or slightly more than the number in the state of Maryland, there was no indication that any district in this vast region would ever become an important cotton manufacturing center. Knitting mills were established, at Detroit, in southeastern Wisconsin, and at a few other points, creating a market for cotton yarn which led to the erection of spinning mills in their vicinity. In 1872 a small establishment of this kind commenced operation at Jonesville, Michigan, and another was later erected at Flint, in the same state. During the early seventies also, a cotton mill was built at Janesville, Wisconsin, containing 10,000 spindles. This was the first establishment in the West to manufacture sheetings and for a time it was very profitable.[14] Indiana had more spindles in 1890 than any other western state. In the early eighties, cotton was shipped overland to California, where it was used by woolen mills in making mixed fabrics; and in 1885 the first cotton mill on the Pacific coast began operations at Oakland. Its skilled operatives came from Scotland, and it was designed to make heavy fabrics such as ducks, denims and bagging for grain sacks, tents and other requirements peculiar to the Far West.[15]

THE SOUTH

The most interesting geographical feature of the history of cotton manufacturing at this time, however, was its recovery from post-bellum depression and its rapid increase in the South. Measured by spindle statistics, this growth is important, but its interest for a student of economic history is not limited to its quantitative progress. It measured in a way the larger

[12] *The Textile Record*, IV, 141, June 1883; V, 72, Mar. 1884; Eleventh Census, *Report on Manufactures, Selected Industries*, 187–189.

[13] *The Textile Record*, III, 245–246, Sept. 1882.

[14] Webber, *Manual of Power*, 73; *The Textile Record*, II, 227, Aug. 1881; American Iron and Steel Association, *Bulletin*, VIII, 364, Dec. 3, 1874; *Boston Journal of Commerce*, XXVII, 245, Apr. 3, 1886.

[15] *Commercial and Financial Chronicle*, XXXIV, 323, Mar. 18, 1882; *Boston Journal of Commerce*, XXVI, 235, Sept. 26, 1885.

economic recovery of the South, and recorded some aspects of the broad industrial effect of the substitution of free for slave labor.[16] Technically and commercially this development reproduced many of the characteristics of the growth of the same industry in New England fifty years earlier, and it illustrated in an interesting way the influence of a new manufacturing industry upon what had previously been exclusively agricultural communities.

This development was entirely in the vicinity of the cotton fields, and did not extend to the Southern border states, which resembled in this respect their neighbors north of the Ohio and farther west. Virginia reported only 17,000 more spindles in 1890 than twenty years before. These were mostly at Manchester and Petersburg, immediately south of the James, though a prosperous establishment was in operation at Danville.[17] In Tennessee the increase of spindles was relatively greater, the number rising from 36,000 in 1880 to 97,000 ten years later; but that growth was negligible compared with the progress farther south. This state had been one of the first west of the Alleghenies to use Arkwright machinery, and it raised cotton within its borders, but its industrial energy and capital were diverted largely to iron-making, lumbering and other branches of manufacture of the extractive type. During the eighties Memphis had a small mill for making sheetings, which was not very successful. A cotton factory was erected at Chattanooga during the general manufacturing boom attending the growth of that city as an iron-making center. Nashville had the principal mills in the state and small establishments existed at other points, bringing the total number by 1890 up to twenty.[18]

Both of the Carolinas developed a cotton industry of respectable dimensions between 1870 and 1890. According to the census in 1870 North Carolina had about 42,000 spindles and South Carolina 31,000 spindles. By 1880, there were 54 cotton mills in North Carolina, most of which were thriving.[19] All of these were small establishments, some of which dated back for half a century or more while others were very recent. They occupied sites immediately on the stream that supplied their water power, and in mountain villages belonging for the most part to their proprietors. Five years later the number of little mills of this character and the number of spindles had more than doubled, and here and there a larger establishment had been erected.[20] The 20,000-spindle mill had not yet appeared, but the 15,000-spindle mill— usually operating a few hundred looms—was

[16] Mitchell, *The Rise of Cotton Mills in the South*, 59–63.

[17] Eleventh Census, *Report on Manufactures, Selected Industries*, 189; *Boston Journal of Commerce*, XXIV, 195, Aug. 30, 1884; *Historical and Descriptive Review of the Industries of Richmond*, 1884, p. 49.

[18] Webber, *Manual of Power*, 73; Killegrew, *Tennessee, its Agricultural and Mineral Wealth*, 1876, 1101; *Commercial and Financial Chronicle*, XXVII, 466, Nov. 2, 1878; Memphis, Chamber of Commerce, *Report*, 1883; *Boston Journal of Commerce*, XXVII, 141, Jan. 23, and XXVII, 238, Mar. 27, 1886; Eleventh Census, *Report of Manufactures, Selected Industries*, 191.

[19] American Iron and Steel Association, *Bulletin*, XIII, 107, Apr. 30, 1879; XIV, 140, June 9, 1880.

[20] Hillyard, *The New South*, 139.

already familiar.[21] Several of the smaller establishments in North Carolina were engaged in making plaids, a fabric particularly popular among the Celt descended highlanders in this state since the beginning of the industry in the thirties.[22]

Between 1870 and 1890 North Carolina's spindles increased from 40,000 to 338,000, or more than eightfold, while the number of mills rose from 33 to 91, or nearly threefold; and at the latter date she ranked next to Georgia among the southern states in cotton machinery. Nevertheless she continued to be the typical small mill state of the south. While the average number of spindles per establishment in 1890 was over 6,000 in Alabama, 8,400 in Georgia, and nearly 10,000 in South Carolina, the number in North Carolina was only 3,700.[23]

Even before the Civil War, when South Carolina had the largest cotton factory in the South, a tendency toward concentration was beginning to manifest itself in that state.[24] A local survey of the industry in 1880 showed 18 establishments, controlled by 17 companies, ranging in size from 264 spindles to 24,000 spindles. The largest company operated 2 factories and 35,000 spindles. One-third of the mills were in Greenville County and one-third in Spartanburg County, though nearly half of the spindles in the state were in three factories in Aiken County. The small mills were products of topography and tradition, were financed with local capital, and survived in part from an earlier era in the original spinning centers of the South, near the headwaters of the river systems that supplied their power. The large establishments were as a rule of more recent date, were to some extent promoted by northern capital and by Charleston merchants and bankers, and were situated near important towns and commercial centers.[25]

The typical Southern mill village with its neat wooden houses, its school building and its church, all provided by the proprietor, which had appeared before the Civil War, continued to afford the setting for this industry. Graniteville, the pioneer town of this kind, was already between 30 and 40 years old and contained some 230 operatives' residences. The mill workers were entirely native whites of the vicinity. Companies sometimes operated besides their cotton factories a flour mill and several cotton gins, receiving a part of their cotton at the factory in the seed, where it passed directly from the farmer's wagon to the ginning room. In remoter localities such mixed establishments sometimes included a saw mill, a planing mill, and a room for carding wool to be manufactured into homespun by the country people.[26]

[21] *Textile Record*, II, 288, Oct. 1881; *Boston Journal of Commerce*, Oct. 10, XXVI, 258 and XXVII, 59, Nov. 21, 1885.

[22] *The Industrial South*, VI, 372, Sept. 1886.

[23] Eleventh Census, *Report on Manufactures, Selected Industries*, 188–189.

[24] *Cf.* Webber, *Manual of Power*, 73.

[25] Kohn, *The Cotton Mills of South Carolina*, 20; Mitchell, *The Rise of Cotton Mills in the South*, 236, 267.

[26] South Carolina Department of Agriculture, *The Cotton Mills of South Carolina*, 1880, 5, 10, 16.

The same paternal regime prevailed in these mills and mill villages that had been characteristic of New England mill towns 50 or 60 years before, when the operatives in that section also were mostly of American stock. The New England mill boarding-house seems never to have been as typical of the Southern mill village as it was of its predecessors on the banks of the Charles and the Merrimac. Partly, no doubt, this was due to the larger employment of children in the South, where, as at an earlier period in Rhode Island and Southern New England, the earning capacity of the younger members of the family attracted the parents also to the vicinity of the mills. In 1881 a visitor described a Southern mill village on the Flint River near Huntsville, Alabama, as follows:

"The factory is large and roomy for the machinery, and everything seemed more cozy and comfortable than in Northern factories. The young women were all American, natives of the country around. They all appeared modest and pleasant, and the Major said there was no vice in the factory. Each family has a house on the land of the corporation, a large garden, and a cow. The houses seemed to me wonderfully large after my acquaintance with New England factory 'tenement houses.' Think of a house more than forty feet long for one family of operatives! This is the length of each dwelling at the Bell factory, and each one has in addition a detached kitchen. In every home I saw a sewing machine. All have open fire places. Major Echols was evidently regarded as a friend by the families on whom we called. He is a kind of patriarch of the community of 300 inhabitants—a fatherly king over them. No liquor is sold except under his direction. There are a church and a school. The children earn from $8 to $12 per month, the women and men from $12 to $20. All raise their own vegetables. Every house has a pretty door yard with shrubbery and flowers. I thought it seemed a happy little community."

The cotton mill here described had been in operation more than 40 years and was a direct development from the plantation. Before the war the operatives had been negro slaves.[27]

The paradoxical combination of paternalism and individualism, one phase of which was illustrated in this little village, characterized a stage in the development of industry which was not peculiar to the South or to the United States. But curious evidences keep recurring to suggest that the resistance which a farming people accustomed to self-direction offered to industrialization continued for a long time to play a part, though a subordinate and futile one, in the manufacturing history of the South. Efforts were made repeatedly to bring the factory to the farm. In Louisiana hopeful inventors tried to perfect apparatus that would enable the man with 40 or 50 acres of cane to convert his crop into sugar in his own barn or wagon shed. During the late seventies a machine was invented by a Memphis mechanic to spin yarn directly from seed cotton. Several of these little "Clement mills," as they were called, were at one time in operation in Georgia and the Carolinas. Six were reported in these states in 1879, where they were visited daily by crowds of country people. It was hoped

[27] American Iron and Steel Association, *Bulletin*, xv, 85, Apr. 6, 1881.

that they "would make an essentially Southern industry," by which was meant, doubtless, that they would render the planter independent of the mill owner. The gin, already a familiar piece of machinery to every intelligent cotton raiser of the South, was connected directly to carding cylinders, which transferred the slivers to the roving frames and spindles, from which they came out in the form of yarn. These little mills, cost $3,500 and were reported to be earning remarkable profits—from 30 to 60 per cent a season. Naturally, however, they did not reverse the course of manufacturing progress and substitute a movement toward dispersion for the world-wide tendency toward concentration, although local economists demonstrated at the time by unquestionable figures that these tiny establishments were much more profitable than their larger neighbors.[28]

Another characteristic of Southern textile manufacturing at this time was the survival of the practice of manufacturing a great variety of fabrics in the same establishment. In 1875 the mills at Wesson, Mississippi, which were owned by one of the largest cotton planters in the South, spun both wool and cotton and wove cotton Osnaburghs and sheetings, merino-filled cassimirs in eight or ten colors, "three leaf" cassimirs, doe skins, tweeds of various patterns, several grades of jeans with all-wool filling, and three or four grades of linsey. In addition to this the Company manufactured ready-made clothing. Both fabrics and clothing were retailed directly to consumers as well as wholesaled to country merchants.[29]

The geographical concentration of cotton spinning and weaving, which we have noted in case of South Carolina, and which existed also in North Carolina despite the dispersion of the industry there in small establishments accommodated to the numerous little water powers and the more primitive transportation conditions of her hill country, became still more marked in the region of larger water powers at the fall line of the more important rivers of the extreme South Atlantic and the Gulf Coast plain. In Georgia cotton manufacturing was carried on mostly in the immediate vicinity of Columbus and Augusta. Furthermore a large portion of the spindles in South Carolina were almost immediately across the river from the latter city and commercially tributary to it. The early manufacturing progress of both these towns has already been described. In 1874, seventeen cotton mills were in operation in Augusta and its immediate neighborhood. Despite the ensuing depression, new undertakings were promoted there as early as 1877, when two companies, financed respectively by Massachusetts and by Pennsylvania capital, were organized to take advantage of the low cost of building and machinery to erect new factories and enlarge existing ones in that city. This was followed by two even larger undertakings three years later, also financed, at least in part, by Northern capital.

[28] American Iron and Steel Association, *Bulletin*, XIII, 314, Dec. 10, 1879; XIV, 221, Sept. 8, 1880; National Association of Wool Manufacturers, *Bulletin*, X, 89, Jan. 1880; Mitchell, *The Rise of Cotton Mills in the South*, 154, 263.

[29] American Iron and Steel Association, *Bulletin*, IX, 26, Feb. 3, 1875.

In describing the ceremonies attending the opening in 1882 of one of these mills, which would have been a notable establishment even in the North, a correspondent observed that in front of its offices stood as a monument of the past the giant chimney of the Augusta Powder Mills, which was then the property of the Confederate Survivors' Association.[30] A new power canal was opened at Augusta about this time, adding several thousand horsepower to the quantity formerly available. By the close of the period we are describing, the 13 cotton mills in Augusta and its tributary territory contained well toward a quarter of a million spindles and more than 5,000 looms.[31]

Columbus, Georgia, claimed in the middle eighties to have the largest cotton mill in the South, with nearly 50,000 spindles and 1,500 looms.[32] North Carolina, South Carolina and Georgia were the leading cotton manufacturing states, but old mills were enlarged and new ones were built in Alabama, Mississippi, Louisiana, Arkansas, Texas and Florida. New Orleans was one of the most important spindle centers in this section. The Maginnis mills in that city, erected in 1882, began operation with 18,000 spindles and 450 looms. Two other mills had respectively 10,000 and 3,300 spindles. All were engaged in the manufacture of heavy fabrics by steam power, particularly goods suitable for bagging, which were in great demand in the country tributary to this important shipping center. Within six years of their establishment, the Maginnis Cotton Mills increased their spindles to 40,000 and, by the close of the period we are describing, they were operating 50,000 spindles and 1,500 looms.[33]

NORTH VERSUS SOUTH

Throughout this period the relative advantages for cotton spinning possessed by the South and by New England were actively debated. For several years the scepticism that prevailed in the North as to the possibility of establishing a successful large-scale industry in the cotton states refused to be shaken by the steady increase of spindles in that section. A Maine manufacturer returning from Atlanta in 1881 was very doubtful as to the prospects of the cotton mills in that vicinity. He thought southern spinners were handicapped by an unfavorable climate, by high rates of insurance and interest, and by careless, apathetic, and indolent employes, who made labor costs higher than in New England. The saving in raw-cotton freights was partly counterbalanced by higher freights on manufactured goods, which were usually shipped to Northern markets. Edward Atkinson, in an address made at the Atlanta Exposition the same year,

[30] American Iron and Steel Association, *Bulletin*, VIII, 316, Oct. 22, 1874; XI, 81, Mar. 21, 1877; XIV, 132, June 2, 1880; XV, 153, June 22, 1881; *The Textile Record*, III, 79, Mar. 1882.

[31] *Manufacturers' Record*, XX, 9, Oct. 17, 1891; *cf. Commercial and Financial Chronicle*, XL, 631, May 23, 1885; American Iron and Steel Association, *Bulletin*, XVIII, 193, July 30, 1884.

[32] *Manufacturers' Record*, VII, 233, Apr. 4, 1885.

[33] *American Textile Manufacturer*, II, 81, May 1882; *Boston Journal of Commerce*, XXII, 274, Sept. 19, 1883; *Manufacturers' Becord*, XXIII, 24, Feb. 10, 1893.

said that while wages were lower in the South, the mills in that region employed thirty more operatives per thousand spindles than their Northern competitors. He did not consider the southern climate a special disadvantage and thought that the best mills could be operated as economically in the South as in the North. But capital was less abundant and demanded higher profits in the plantation states. Moreover the North had a great advantage in its better railway system.[34] Four years later a Georgia journal criticized Southern mills as expensively constructed, faultily arranged, and lacking in their operation the high grade of skill prevailing in the North. In fact an estimate made in 1886 indicated that a factory for coarse goods would cost from 10 to 20 per cent more in the South than in New England.[35]

About 1890 South Carolina mills were supposed to have an advantage over those of Massachusetts of three-quarters of a cent a pound in freights, one-fourth lower wages and 10 to 20 per cent more output per unit of machinery. But this was in factories making standard sheetings and drills of coarse texture, which had largely supplanted the diversified fabrics so characteristic of the earlier period. Very few fine goods were made in the South as yet, although some attention was being given to the possibility of producing such fabrics there—to the growing concern of New England manufacturers.[36]

Freight charges on raw cotton and finished goods were a prominent talking point in all discussions of southern manufacturing progress at this time. The railways of that section adjusted their rates with a view to encouraging the erection of cotton factories, as they did to favor building iron furnaces, in the country tributary to their lines. A North Carolina mill owner described this policy to the members of the New England Cotton Manufacturers' Association in the following heartening fashion:

> "For the purpose of inducing the establishment of manufactories along the line of the road, they take the bale of cotton from the fields to the mill, and after it is manufactured take it off to the North, at the same rate, and sometimes at a less rate, than the original bale of cotton could be brought through for"— [i. e. to the northern market].[37]

Compared with the North, the number of spindles in the South was still relatively small. Their ratio of growth rather than their absolute increase impressed students of the industry. According to the census of 1860 this section had at the outbreak of the Civil War 165 cotton mills with 299,000

[34] *American Textile Manufacturer*, I, 203, 210, Dec. 1881; New England Cotton Manufacturers' Association, *Proceedings*, Nov. 30, 1881; 29–31; Mitchell, *The Rise of Cotton Mills in the South*, 120–121.

[35] *Macon Telegraph*, quoted in *Boston Journal of Commerce*, XXVI, 215, Sept. 12, 1885; *id.* XXVII, 144, Jan. 23, 1886; a comparison even more pessimistic for the South is to be found in *Boston Journal of Commerce*, XXXIX, 216–217, Jan. 9, 1892.

[36] *Boston Commercial Bulletin*, quoted in *Manufacturers' Record*, XIX, 14, Apr. 11, 1891, New England Cotton Manufacturers' Association, *Proceedings*, Oct. 30, 1889, p. 33; *cf.* Tompkins, *Cotton Mills, Commercial Features, Passim.*

[37] New England Cotton Manufacturers' Association, *Proceedings*, Oct. 30, 1889, 116.

spindles, an average of only 1,800 spindles per establishment. These mills consumed annually scarcely 100,000 bales of cotton. During the subsequent hostilities, as we have seen, most of the mills were destroyed or considerably damaged. Yet five years later, when the next decennial census was taken, the South had more than recovered from the War's effect, having 29,000 spindles more than when hostilities began. During the following decade the number of spindles in this section rose to 542,000 and the consumption of cotton nearly doubled. This progress though encouraging was not remarkable. A general revival began throughout the South soon after 1880, which is sometimes associated with the Cotton Exposition held at Atlanta in 1881. It is certain that the attention of Northern visitors and mill owners was called at this time to the advantages which the South offered, particularly for the manufacture of coarse goods; but the heartening effect upon Southern business men was even more important. In spite of the depression that everywhere checked the progress of cotton spinning in the early eighties, the number of Southern spindles increased three-fold during the following decade and the next census showed 239 establishments containing in round numbers 1,554,000 spindles and consuming 526,000 bales of cotton annually.[38] By the end of 1895 the number of mills in operation or under construction in the South was nearly 400, containing well toward 3,000,000 spindles. While the average mill in 1860 operated as we have said, less than 2,000 spindles, the average per mill at the latter date was about 7,000 spindles. Meanwhile the quantity of cotton spun per spindle annually had increased nearly one-half, and most of the new mills contained from 10,000 to 25,000 spindles.[39]

SPINDLE STATISTICS

The National Association of Cotton Planters and Manufacturers, organized in the late sixties, attempted to gather complete statistics regarding the spinning mills and cotton consumption in the United States in 1868, 1869 and 1870. This Association became defunct the following year, but the statistical work it had begun was continued by the *Commercial and Financial Chronicle*. According to this journal there were in the United States, on July 1, 1874, 847 cotton mills, operating 9,415,000 spindles and 187,000 looms, and consuming annually 1,223,000 bales, or about 568,000,000 pounds, of cotton. At this time American mills manufactured more sheetings and shirtings than any other fabric, or some 707,000,000 yards altogether. They also wove 588,000,000 running yards of print cloth and 306,000,000 yards of twills, Osnaburghs and jeans per annum. All other fabrics, of which the most important were gingham and duck, amounted to about 70,000,000 yards. Print cloths sold at six cents per yard or a shade lower, while jobbers obtained about twice this price for

[38] Mitchell, *The Rise of Cotton Mills in the South*, 122–123; Eleventh Census, *Report on Manufacturers, Selected Industries*, 188–189.

[39] *Commercial and Financial Chronicle*, LXI, 990–992, Dec. 7, 1895.

standard prints. Sheetings and drills retailed at $12\frac{1}{2}$ cents to 13 cents a yard. The outstanding feature of the statistics of woven goods during the next few years was the relatively rapid increase in the output of print cloth, which in 1875 exceeded the total production of drills, sheetings and other plain fabrics.[40]

In 1876, according to the reports published at the time of the Centennial Exposition, the United States ranked second among cotton manufacturing countries, Great Britain had four spindles to our one, but we had almost twice as many spindles as either France or Germany, our next competitors in order. We operated a little more than 14 per cent of the cotton machinery in the world and consumed upward of 20 per cent of the cotton manufactured by power. The product of our spindles and looms was almost entirely used at home, and only about 7 per cent was exported. Great Britain, on the other hand, shipped 85 per cent of the cotton goods she made to foreign countries. Our competitive advantages in respect to Great Britain and Europe were our proximity to the cotton fields and our cheap water power. Some machine and finishing room supplies, such as leather, lumber, oil and starch, could also be bought cheaper in America than abroad, but in respect to wages, skill, cheap capital and marketing organization our transatlantic rivals were more fortunately situated than ourselves.[41]

During the middle eighties the growth of spinning machinery in the United States was rather erratic, new building and extension coming almost to a standstill at times on account of temporary over-production. It is noticeable that the most optimistic reports regarding the status of the industry usually came from the South.[42] In 1888–1889 the installation of new machinery was actively resumed.[43] Figures gathered by private associations and those published by the census do not agree, the former reporting a considerably larger number of spindles in existence and in operation than did the Government authorities. According to the census, 14,088,000 spindles and in round numbers 325,000 looms were enumerated in 1890, an increase during the previous decade of 32 per cent in the number of spindles and of practically 44 per cent in the number of looms. But these statistics appear to have been incomplete, for competent private enumerations the following year place the number of spindles in operation in the United States at 14,781,000. According to the census we manufactured this year more than 955,000,000 square yards of print cloths and 962,000,000 square yards of brown or bleached sheetings or shirtings, which seems to disprove the existence of the strong tendency apparent during the middle seventies for print cloths to gain over heavier plain fabrics.[44]

[40] *Commercial and Financial Chronicle*, XIX, 515–517, Nov. 21, 1874; XXII, 4–5, Jan. 1, 1876.

[41] U. S. Centennial Commission, *Reports and Awards*, V, Group VIII, p. 13; *cf.* National Association of Wool Manufacturers', *Bulletin*, VI, 77, Apr. 1876.

[42] *Commercial and Financial Chronicle*, XXXIX, 285, Sept. 13, 1884; XLI, 295, Sept. 12, 1885; XLV, 328, Sept. 10, 1887.

[43] *Commercial and Financial Chronicle*, XLIX, 328, Sept. 14, 1889.

[44] *Commercial and Financial Chronicle*, LV, 656–658, Oct. 22, 1892.

CHAPTER XXXV

TRADE CONDITIONS IN THE COTTON MANUFACTURE

PANIC AND POST-PANIC DEPRESSION

The prosperity of cotton manufacturing was as checkered during these twenty years as that of most other branches of industry, although its fluctuations were not quite as extreme as those we have noted in case of iron and steel.[1] By the autumn of 1873 cotton mills were rapidly resuming operation after the panic shut-down, in face of a continued demand for cotton goods, but the revival was neither as complete nor as enduring as was at first anticipated. In the autumn of 1874 the treasurers and managers of the larger New England companies held two important meetings in Boston and Providence at which they adopted resolutions in favor of curtailing operations at least one-third, for a period of three months. At this time the 10-hour law went into effect in Massachusetts, reducing the normal working time of their establishments. Nevertheless, the market remained stagnant in spite of reduced production, and price cutting continued. Yet it was estimated that the per capita consumption of domestic cotton fabrics had risen from 33 yards to 39 yards within fifteen years.[2]

In 1876 the Atlantic mills of Lawrence and an important dry goods jobbing house suspended in order to liquidate their properties, though with assets reported to be considerably above their liabilities. By this time it was recognized that the panic of 1873 was not a temporary phenomenon and the spirit of hopefulness which had prevailed during even the darker hours of this crisis had given place to confirmed depression or resignation.[3] The market opened in 1876 very low, but at prices slightly above the cost of production. In August of that year more than 1,000,000 spindles were idle in New England alone, not counting the number running on short time. About half of these were in print-cloth factories. Similar conditions prevailed in New Jersey, Pennsylvania and elsewhere.[4]

[1] *Cf.* however, New England Association of Cotton Manufacturers, *Proceedings*, Oct. 29, 1879, pp. 102–103.

[2] *Commercial and Financial Chronicle*, XX, 166, Feb. 13, 1875.

[3] *Commercial and Financial Chronicle*, XXII, 560, June 10, 1876; Dana, *Cotton from Seed to Loom*, 242.

[4] *Commercial and Financial Chronicle*, XXIII, 124, Aug. 5, 1876; American Iron and Steel Association, *Bulletin*, X, 226, Aug. 23, 1876.

CHANGING MERCANTILE PRACTICE

The worldwide pressure of accumulated stocks upon the cotton goods market, which was felt severely at this time, was ascribed in part to changes in commercial practice. With the opening of the Suez Canal, the substitution of swifter steamships for sailing vessels, and the extension of the telegraph to the Far East, the old custom of holding large supplies in warehouses at Oriental ports and other distant depots ceased and the quantity of goods in transit was cut down by speedier transportation. Merchants began to carry very small stocks, depending on their ability to order at short notice from the manufacturer to replenish them. Indeed they were forced into this practice by the insistent demand for goods of the latest style and fashion. It was suggested with some show of plausibility that the liquidation of these accumulations of outport goods had been sudden enough and large enough to keep the market at a lower tone than normal for two or three seasons.

The same tendency was noted in the United States, where the rapidity with which orders could be executed, especially with machinery lying idle and factory owners eager for commissions, disposed merchants to carry very small stocks—an inclination intensified, of course, by the recent decline in prices. The latter was popularly attributed to over-production, but that contention was difficult to prove. Although our cotton mills used as much cotton in 1875 and 1876 as during more prosperous years, they found themselves with decreased quantities of goods when they made their annual inventories. More domestic fabrics were being marketed than manufactured; nevertheless prices continued to fall. The psychology of this was, according to the explanation of the time, that the accumulated stocks, which had formerly been dispersed far and wide in warehouses and on merchants' shelves, were now piled up at the factories where they were impressively visible both to sellers and to buyers.[5]

THE CENTENNIAL YEAR REVIVAL

By the end of 1876 the market became aware of the true condition and there were distinct evidences of a revival. During the following year prices started to advance and confidence quickly strengthened. Southern mills were in a rather more satisfactory situation than those in the North, and in the autumn of 1877 that section presented "a more hopeful condition than any other portion of the country." A recent fall in the price of raw cotton encouraged a return to heavier fabrics which could be exported to China, Africa and South America; and while the domestic market was dormant price conditions had encouraged an increased use of cotton as compared with wool.[6]

[5] *Commercial and Financial Chronicle*, XXIII, 269–270, Sept. 16, 1876.

[6] *Commercial and Financial Chronicle*, XXIV, 100–101, Feb. 3, 1877; XXV, 2–3, July 7, 1877; XXV, 251, Sept. 15, 1877.

Yet this promise of a revival was soon clouded by a second slump. Rumors of war in Europe followed by the outbreak of hostilities between Russia and Turkey disturbed market conditions throughout the world. During the previous five years our exports of cotton fabrics had more than quadrupled, although their total value was still less than $10,000,000. Added to this growing outlet for our surplus, however, was the disposition just mentioned of our own consumers to employ cotton for new uses with lower prices. The very depression which the country had passed through taught our manufacturers new economies and stimulated mechanical improvements. It was felt that the country was better qualified to resist foreign competition than ever before. Cotton was substituted for wool in knit goods because the people demanded cheaper garments, which could not be made of the latter fiber. The same condition prevailed with regard to many kinds of cloth usually classed as woolens, which now were made of wool and cotton, carded in combination. The active demand for cotton warp even during the worst of this depression was significant of this change.[7]

THE BOOM OF 1879

The first signs of a more enduring revival appeared in 1879, when a wave of speculative enterprise swept over the United States and was followed by an active demand for cotton goods sufficient, indeed, to change completely the aspect of the industry even in Great Britain. The only setback was to exports, which declined in both quantity and value between 1878 and 1880, because manufacturers refused to send goods to China when they could get more for them at home. In the reaction from the economy of the lean years preceding, our people were demanding better fabrics, with the result that the production of fine cloths was encouraged. Raw cotton declined but the price of cotton goods held firm with the result that in 1879 mill profits were unusually large.[8] In 1880 a South Carolina manufacturer testified that his business was "25 per cent better off than it was a year ago;" and he did not consider national legislation necessary to encourage it. We may add in passing that he approved the state law exempting new machinery from taxation for ten years because it equalized conditions with other states where similar laws were in force.[9] This improvement was not checked by the fact that the American cotton crop had risen within three years from 5,100,000 bales to 6,600,000 bales and enough spindles were in operation to manufacture it.

American mills had by this time secured almost a monopoly of the domestic market, not only for coarse unbleached cottons—which they had always held—but also for bleached, printed and dyed cotton piece goods.

[7] *Commercial and Financial Chronicle*, xxv, 250–251, Sept. 15, 1877; xxvii, 268–269, Sept. 14, 1878; xxvii, 413, Oct. 19, 1878; New England Cotton Manufacturers' Association, *Proceedings*, Oct. 29, 1879, 101–102.

[8] *Commercial and Financial Chronicle*, xxx, 285, Mar. 20, 1880; xxxi, 272–274, Sept. 11, 1880.

[9] South Carolina Department of Agriculture, *The Cotton Mills of South Carolina*, 1880, 7.

Imports of these fabrics fell from $26,000,000 per annum before the Civil War, when the population of the United States was but 30,000,000 to less than $1,000,000 twenty years later when the population was 50,000,000. Meanwhile the price of standard sheetings, drills, shirtings, print cloths and calicoes had fallen consistently, in some instances as much as one-fourth.[10]

The revival in cotton manufacturing which occurred at this time was world wide. Times were unusually prosperous in Europe and Great Britain as well as the United States. Signs of overproduction, especially of print cloths, first began to manifest themselves again in 1882. The cost of manufacturing was rising and it was not possible in face of accumulating stocks to increase correspondingly the price of goods. As a result a number of print-cloth mills changed over to the manufacture of gingham, a measure which we shall see repeated subsequently when the former branch of the industry was in the doldrums. Poor crops interfered with the American market by lessening the call for fabrics from the farming sections and as a result of speculation in raw cotton European spinners could purchase this material cheaper than American spinners.[11]

THE DEPRESSION OF 1883

In 1883 the depression in most branches of industry had become acute and its cause and probable duration were widely discussed. Some attributed the unsatisfactory conditions in the North to the increasing competition of the South, others to the growing demand for finer goods than the older American staples, and still others to the unorganized and indeed anarchic conditions of production. Some factories were running night and day, while others were shut-down. Gingham weavers in Maine were paid $8 to $10 a week for work for which Philadelphia weavers received $11 and $15. Even in Philadelphia mills the average pay of operatives in different establishments ranged all the way from $4.35 a week to $7.35 a week. It was observed at this time that cotton mill wages—especially for weaving—were lower in New Jersey than in Philadelphia and lower in New England than in New Jersey. Half of the looms ordinarily running on mixed cotton and wool goods in Philadelphia were reported to be idle. Conditions were somewhat better in the larger mills of Massachusetts and Rhode Island. Simultaneously with this declining market for colored and printed cotton goods the worsted industry was booming. Mills manufacturing such fabrics were sold ahead, spinners were unable to meet their orders and long-staple wool had almost disappeared from the market.[12] A familiar symptom of the prevalent depression in prints was the heavy auction sales

[10] American Iron and Steel Association, *Bulletin*, XVI, 33, Feb. 1, 1882.
[11] *Commercial and Financial Chronicle*, XXXV, 285, Sept. 9, 1882; XXXV, 561–562, Nov. 18, 1882.
[12] *Textile Record*, IV, 12, 27, Jan. 1883.

in New York. On a single Thursday in August 1883, 17,000,000 yards of cloth were sold by a single New York auction house at prices from 5 to 25 per cent below the ruling quotations previous to the sale.[13]

Yet even in the cotton industry some branches continued fairly active. Relatively less curtailment of production occurred in the South and profits, though declining, were still satisfactory in that region. A good market for fine plain goods, including the better class of shirtings, existed in New England. The depression affected most severely northern producers of print cloths and makers of coarser cotton fabrics which were beginning to be manufactured extensively in the South. Such crises hastened the elimination of small and poorly equipped mills. Indeed in the present instance nature seems to have lent her aid to this process. Smaller New England factories suffered severely from a protracted drought and an abnormally cold winter, which forced the numerous little plants situated on minor streams and entirely dependent on water power to close for several months, while larger establishments situated on rivers with a greater drainage area and having auxiliary steam power were not affected.[14]

Evidence multiplied of the psychological as well as the more immediately economic influence that the rise of southern manufactures had upon the country. In 1884 an incipient movement in favor of a protective tariff manifested itself in the South, where mill owners agitated the formation of an industrial league to fight free trade.[15] Northern manufacturers were inclined at times to exaggerate the effect of Southern competition, so that the technical and financial press of the North felt called upon to reassure them on that score. Experts pointed out that the best organized and equipped mills of the North always made a profit, even when their smaller and weaker neighbors were losing money; that the competitive margin between different mills in the North was probably as great as the average margin between Northern and Southern mills as a group; that there is always a tendency for freight rates and commodity prices to equalize themselves for different manufacturing centers and that this was particularly true of materials relatively light in proportion to their value, like the textile fibers; that while a single isolated mill in the South might be able to buy its cotton directly from the fields, it was clear that the industrial development of this section would resemble that of New England and cotton mills would tend to concentrate in a few favored localities, where they would be nearly as dependent on long railway freight hauls as the mills of New England. Nevertheless, the persistent overproduction of cotton goods was generally attributed to the rapid growth of spinning facilities in these two widely separated regions, so that in a sense the normal spindle increase was thereby doubled.[16]

[13] American Iron and Steel Association, *Bulletin*, XVII, 235, Aug. 29, 1883.
[14] *Commercial and Financial Chronicle*, XXXVII, 252–253, Sept. 8, 1883.
[15] *Textile Record*, V, 63, Mar. 1884.
[16] *E.g.*, *Commercial and Financial Chronicle*, XXXIX, 284, Sept. 13, 1884.

Attempts to curtail production during these periods of overstock and market stagnation failed for several reasons. Some manufacturers thought the proposed remedy insufficient. Others had on hand a big supply of low-priced cotton and found it profitable to continue at current rates. Still others were making fabrics for which there was still an active demand and saw no reason to stop their machinery as long as they could sell their product. Still other mills, well managed, equipped with the best machinery and commanding an abundance of working capital, were able to make money under all conditions. So there was always a considerable group of establishments whose owners and managers would like to see their neighbors stop but had no intention of doing so themselves. At length, however, conditions reached a point, in the late summer and early autumn of 1884 when managers began to close down independently, so the effect was practically the same in the end as if there had been concerted action. In August of this year it was estimated that half the spindles in New England were idle—"the largest closing movement ever inaugurated." This lasted until December, when all the Fall River mills resumed, intending to continue throughout the winter.[17]

How spotted the situation was, is indicated by the condition of the cotton mills at Biddeford and Saco, Maine, which had an unusually successful season in the very heart of this depression. During 1884 one corporation paid its stock holders 12 per cent, another 6 per cent, and another 5 per cent, distributing these dividends from actual earnings without impairing surplus. The Pepperell Corporation at that place had a surplus equal to its capital of $1,200,000. Another of these profitable mills was still running some of the wooden looms built at the time it was erected in 1845. The explanation was that 50 per cent of the product of the larger corporations at this place was sold in China and East India, where their goods had such a foothold that they commanded a premium above current quotations. It was from these sources and from their growing trade with South America that such companies drew their profits.[18]

Nevertheless, another season was to pass before indications of a general revival began to appear. In fact, 1885 was in some respects the darkest year of this period. The price of print cloth continued to decline, and in April a general stoppage of the Fall River mills was at length agreed upon.[19] By this time the depression had extended to the South, where producers of coarse goods were beginning to feel the full effects of a chronically stagnant market. The change from unbound optimism to distrust and pessimism in that section was very sudden. To quote a contemporary comment, "building factories in the South has been pursued too much as a

[17] *Commercial and Financial Chronicle*, XXXVIII, 497, Apr. 26, 1884; XXXIX, 134, Aug. 2, 1884; American Iron and Steel Association, *Bulletin*, XVIII, 253, Oct. 1, 1884; XVIII, 317, Dec. 3 and 10, 1884.

[18] *Commercial and Financial Chronicle*, XL, 245–246, Feb. 21, 1885.

[19] *Commercial and Financial Chronicle*, XL, 246, Feb. 21, 1885; XL, 486, Apr. 18, 1885.

holiday affair based on the belief in a broad margin for profit over any other section of the country." The disillusionment was severe; for the spinners of that region had not learned the economies of management which similar crises in the past had taught their Northern competitors and they were operating for the most part with a smaller capital than the latter. Taking the country over, in 1885 the pressure of hard times was more severe and the stoppage of mills was more general and protracted, than in any other year of the depression. On the other hand the shrinkage in accumulated stocks of manufactured goods was more decided than ever before. The largest auction of cotton fabrics in the history of the country was held in New York in May of this year, when 20,000 packages were sold in a single day.[20] Cotton was meeting the competition of wool again, for the latter fiber was as low in the summer of 1885 as it had been at any time within half a century, while cotton was between two and three cents a pound higher than it had been a few years before. In spite of the overstock of piece goods in the domestic market, exports instead of increasing actually declined.[21]

THE REVIVAL OF THE LATE EIGHTIES

But the tide was about to turn. By the autumn of 1886 warehouses and merchants' shelves were nearly clear of goods. The reserve of printing cloth at manufacturing centers had fallen from 1,056,000 pieces to 243,000 pieces within a year. At last low prices began to make themselves felt in foreign trade and exports of cotton fabrics again rose. Contemporary writers referred to the summer of 1885 as "about the darkest period the cotton goods trade ever experienced in this country." A year later the mills were not only well employed, but they were beginning again to earn money.[22]

Several lessons were learned during this depression. It was impressed on mill owners that the day of wide margins between cost and selling price had ceased. This margin had been narrowed down to "a mere edge where only skill and prudence ensure one's balance." Indeed, profits often represented nothing more than new economies. The effect of this was seen in the growing concentration of spindles in larger establishments. Almost all the additions to machinery during the latter part of the depression and the first months of the revival were enlargements of existing plants made in order to secure the additional economies which so largely determined profit or loss. In new construction, moreover, provision was made against overproduction by so equipping mills that they could manufacture a variety of goods and thus accomodate themselves readily to the caprices of popular taste.[23]

[20] *Boston Journal of Commerce*, XXVI, 44, May 16, 1885 (bis.); *Commercial and Financial Chronicle*, XLI, 293, Sept. 12, 1885.

[21] American Iron and Steel Association, *Bulletin*, XIX, 155, June 17, 1885; *Commercial and Financial Chronicle*, XLI, 294, Sept. 12, 1885.

[22] *Commercial and Financial Chronicle*, XLIII, 294–296, Sept. 11, 1886.

[23] *Commercial and Financial Chronicle*, XLV, 326, Sept. 10, 1887; XLVII, 309, Sept. 15, 1888.

Although net earnings continued to be small in most branches of cotton manufacturing, the seasons of 1888 and 1889 were unquestionably prosperous. In the autumn of the latter year, Northern mills made from fair to excellent profits on all classes of goods except certain colored cottons such as denim and ticking. Naturally the revival of demand and better prices encouraged additions to machinery and this again tended to hold down the margin of manufacturing profit.[24]

In 1889 the Fall River corporation declared dividends averaging 9.73 per cent, besides allotting satisfactory sums for depreciation and reserve. It should be borne in mind, however, that several of these corporations had suspended dividends at times during the previous depression. In 1885, of 33 major corporations in that city, only 13 made any distribution to their stock holders. Of course, conditions in the print-cloth industry were not representative of cotton manufacturing as a whole. In fact the former had developed into a highly specialized branch of the trade, to some extent independent of other departments of cotton manufacturing and no longer necessarily typical of the entire industry. For example, while print-cloth manufacturers were thus prospering, colored goods continued in over supply.[25]

The season of 1890 was not, upon the whole, as prosperous as its predecessor. A tariff bill was before Congress—always an unsettling matter for any business. Raw cotton was rising and spindles were multiplying. Some alarm as to possible over-production was manifest. The Fall River manufacturers felt it necessary to agree upon a minimum price for print cloths. Southern mills found their trade dragging rather more than that of the North, though the balance sheets of many of the older establishments in this region were most encouraging On the whole, however, that section was feeling the evil results of too much concentration upon a limited number of fabrics. The industry there was also slightly discredited by the fact that a number of factories had been erected mainly for the purpose of booming town lots during the great wave of real estate speculation which was to prove temporarily disastrous for this region in the coming panic. Coarse sheetings and plaids were the principal fabrics woven in the South, and in 1889 manufacturers in that region tried to organize to restrict the production and sale of the latter fabric. They failed at first, but in May 1891 they finally succeeded in combining—with a few exceptions—to establish a joint agency in New York through which all their business in the Northern markets was transacted. This agency was reported to have authority in some measure to regulate styles and production.[26]

[24] *Commercial and Financial Chronicle*, XLIX, 325–327, Sept. 14, 1889.
[25] *Commercial and Financial Chronicle*, XLIX, 677, Nov. 23, 1889.
[26] *Commercial and Financial Chronicle*, LI, 327–328, Sept. 13, 1890; LIII, 350–351, Sept. 12, 1891; *Boston Journal of Commerce*, XXXVIII, 67, May 9, 1891; XXXVIII, 101, May 23, 1891; XXXIX, 110, Nov. 21, 1892.

After the fat years of 1888 and 1889, Fall River dividends declined, the average for 33 corporations in 1891 being less than 5 per cent; but this was followed by a recovery in 1892 and 1893, the average rising in the latter year to 7.95 per cent.[27] The effect of the crisis of 1893 was not felt in the cotton industry until the latter part of the year. After the first of July, however, the number of idle spindles began to increase. Print-cloth manufacturers continued to make money and to run their machinery nearly full time, though with an increasingly narrow margin of profit. In the South the demand for brown sheetings and colored cottons remained active until the end of the second quarter, some mills being hard pressed to keep pace with their orders. But by the third quarter of the year complaint of unsold stocks began to be frequent in almost every branch of the cotton fabric market. Exports were less in both quantity and value than during either 1891 or 1892. Spindles continued to increase, partly as a result of the encouragement given new construction by the promising conditions earlier in the season. By November, a large auction sale of the product of several eastern corporations—the inevitable symbol of a stagnant market—occurred at New York; but this sale, which was the largest since May 1885, was an unexpected success. Some 18,000 packages valued at $2,000,000 found ready buyers. Indeed, the worst part of the immediate depression was over. Most of the shut-downs and other curtailments of operations were in the middle of the summer. A few failures occurred, more particularly in the South, where, however, a resumption of operations had become general by October and November and in several instances satisfactory profits were reported.[28]

EXPORTS

Exports of cotton goods never formed during these two decades an important fraction of total sales, though they did at times steady prices. In fact, during the sixties and seventies manufacturers actually lost ground in the foreign market compared with the promising trade they had established in the earlier part of the century, when the American flag was found in nearly every port. Chile imported in 1874 eleven times as much cotton cloth from Great Britain as from the United States; and the Argentine, which bought 40,000,000 yards of these goods from English mills, purchased only 155,000 yards from American makers.[29] In 1875 New England manufacturers decided to exhibit their goods in Manchester and Liverpool, hoping thus to interest Asiatic customers, who regularly bought in that market, and thus to recover some of their old-time trade; for the United States had sold abroad cotton goods to the value of nearly $11,000,000 in 1860, while its exports were valued at only $2,300,000 in 1872 and

[27] *Commercial and Financial Chronicle*, LIII, 734, Nov. 21, 1891; LV, 833–834, Nov. 19, 1892.
[28] *Commercial and Financial Chronicle*, LVII, 400–403, Sept. 9, 1893; LVII, 872, Nov. 25, 1893; American Iron and Steel Association, *Bulletin*, XXVII, 157, May 24, 1893; XXVII, 221, July 26, 1893.
[29] Brassey, *Work and Wages*, 249.

$4,000,0000 in 1875.[30] Part of the latter goods were handled through Liverpool. British newspapers gave some attention to the movement of certain cotton fabrics, especially print cloths, from Boston to England, where they were said to find a market on account of their superior quality;[31] and between 1875 and 1877 our total foreign shipments more than doubled, rising to $10,236,000, or nearly the 1860 record.[32]

Many protests were made about this time, both in Great Britain and in the Far East, against the heavy sizing of British fabrics; but the practice had its defenders, who asserted that natives of some tropical countries preferred sized goods to those of pure cotton.[33] In 1877 the Fall River cotton manufacturers sent a special agent to South America to study the market there. The result was very satisfactory; agencies for American goods were established at several points in Brazil and sales to that country rose.[34] It is significant of the renewal of American competition in foreign markets that we begin to hear the old familiar complaint that Manchester exporters were stamping inferior goods with counterfeit brands of standard American fabrics.[35]

A paper published at Manchester, England, asserted in 1877 that the adulteration of cotton fabrics had gone so far in that city that colonial and Oriental customers had begun to insist upon American cloths, preferring them for their quality and, it was claimed, for their pattern. One-third of the total weekly exports of cotton goods from New York were reported at this time to go to Liverpool and Glasgow. South America came next in the order of buyers, while the third place was occupied by the West Indies and Canada.[36] Of course it was always possible for British manufacturers to improve the quality of their fabrics when they found the market demanded it; and with lower prices for cotton goods the colonial market called for better qualities. Indeed, English critics attributed the temporary popularity of American calicoes in the British and foreign markets to the fact that they were offered at low prices, possibly at lower prices than similar qualities of English make, and intimated that our mill owners were dumping their surplus goods abroad at less than cost.[37]

Upon the whole, therefore, New England manufacturers were hopeful at this time of conquering speedily and easily a substantial foreign market. When the Centennial Exposition closed the American cottons displayed there were presented to the Commissioners from countries importing this

[30] American Iron and Steel Association, *Bulletin*, IX, 266, Sept. 3, 1875; IX, 346, Sept. 3, 1875.
[31] American Iron and Steel Association, *Bulletin*, IX, 346, Nov. 19, 1875.
[32] Department of Commerce and Labor, *Statistical Record of the Progress of the United States, 1800–1907*, 31.
[33] Edward Atkinson, in *Commercial and Financial Chronicle*, XXIV, 310–311, Apr. 7, 1877.
[34] American Iron and Steel Association, *Bulletin*, XI, 154, June 6, 1877.
[35] American Iron and Steel Association, *Bulletin*, XI, 211, Aug. 8, 1877.
[36] American Iron and Steel Association, *Bulletin*, XI, 283, Oct. 24 and 31, 1877; *Commercial and Financial Chronicle*, XXIV, 601, June 30, 1877; Shepperson, *Cotton Manufactures in the United States*, 8.
[37] *Commercial and Financial Chronicle*, XXV, 563, Dec. 8, 1877.

class of goods, in order to advertise them in those markets. Despite the scepticism of cautious observers, who pointed out that the real problem confronting our mill owners was to capture the domestic market first and that our imports of cotton fabrics from Great Britain alone were greater than our aggregate exports to all countries, computations were made to show that American factories could produce goods for less than their transatlantic rivals, a view shared by some manufactures in England. It was argued that American spinners could secure their raw materials cheaper, and their labor, measured in output, as cheaply as those of any other country; but that they were sadly hampered at this time by the paper currency, which amounted to a heavy tax upon industry, and by the shipping laws, which prevented the cheap distribution of their products to overseas customers.[38]

The peak of the agitation in favor of foreign markets was reached about 1877, partly because the stimulus of the Centennial was still felt, partly because the depression at home kept the domestic demand at a low level, and partly because of the feeling just mentioned that the general decline of prices in the United States since the Civil War, which was a very spectacular economic phenomenon, had brought our costs of production down to the European level. Exports had risen rapidly enough to encourage this opinion. In 1873 America shipped abroad only 12,000,000 yards of cotton goods; four years later these figures had risen to 111,000,000 yards.[39]

Nevertheless, as a British manufacturer pointed out at this time, the investment per spindle in the existing cotton mills of the United States was larger than in those of Great Britain, and a relatively high profit was demanded on this investment. The cost of power was probably higher in America than abroad; and the price our manufacturers paid for cotton in the Southern market was usually somewhat above the Liverpool price. New England buyers took their pick and paid more than British exporters could afford to pay, so that they generally put the latter out of the market "until they were supplied:" Furthermore, to quote the same authority,—

> "The cloth made in American mills is of a superior quality, of which the sale is and always will be limited. It is like the sale of special brands of fine wine—there is a sale, but it can never be the sale of the great consumption of the world."[40]

This prediction proved true. With the revival of prosperity at home and the resulting rise in costs of production, American exports began to decline. In 1880 shipments to China, for example, were one-quarter less than in 1879. British manufacturers had improved the quality of their fabrics to meet the growing demand for better goods.[41] About this time

[38] Dana, *From Seed to Loom*, 256–257; *Commercial and Financial Chronicle*, XXIV, 167–169, Feb. 24, 1877; XXIV, 601, June 30, 1877; XXV, 563, Dec. 8, 1877; American Iron and Steel Association, *Bulletin*, XI, 326, Dec. 12, 1877.

[39] American Iron and Steel Association, *Bulletin*, XII, 195, Aug. 21 and 28, 1878.

[40] William Bigg's letter in *Commercial and Financial Chronicle*, XXIV, 263–264, Mar. 24, 1877; *cf.* Reply of Edward Atkinson, *ibid.*, XXIV, 285–286, Mar. 31, 1877.

[41] *Textile Record*, II, 64, Mar. 1881.

the Southern mills entered the China market, and in 1881 one Augusta company shipped to that country goods to the value of a quarter of a million dollars. In 1884 many Southern mills, especially in Georgia, were sending a considerable quantity of goods, relatively to their entire output, to China, Africa and Mexico; but they recognized that this outlet was open only during eras of low prices. When sheetings, for example, commanded 8 cents a yard in the United States, it was more profitable to sell them at home than abroad. The expanding market in Africa would, it was thought, take the entire product of the Georgia mills if they were disposed to ship exclusively to that point.[42]

But although stocks of goods accumulated in America during the depression of 1883 and 1884, exports actually declined both in quantity and value, possibly because that was also a period of stagnant markets and low prices for British manufacturers. Indeed, the slight increase that did occur in the latter part of the decade accompanied a revival in the domestic market. The almost stationary character of this branch of our foreign trade is sufficiently indicated by the fact that the total exports of cotton fabrics from the United States in 1890 were valued at about $1,000,000 less than those thirty years before, on the eve of the Civil War.[43]

Throughout this period the cotton goods we exported were mostly coarse unbleached and uncolored cloths, which could be manufactured at the lowest labor cost and in which the expense of raw materials was relatively the largest component of total value. It was in the production of such fabrics that American manufacturers were most nearly on a par with their competitors abroad. A British student of this industry says that about 1890—

> "It was commonly agreed that the cost of spinning was lower in England and the cost of weaving most simple fabrics was lower in America, though the weekly earnings in the United States and England were roughly as three to two."

This was partly because male weavers were more commonly employed in Great Britain, and female weavers in America. Possibly American mills had some advantage at this date in respect to looms, which were more largely automatic than those used across the water.[44]

COTTON MANUFACTURING IN COMPETING COUNTRIES

India, which was the first Asiatic country to develop a modern cotton industry, more than doubled her spindles, from 1,453,000 to 3,402,000, between 1879 and 1892; Japan, which entered this field of manufacturing later, had less than half a million spindles at the latter date. Neither had as

[42] *Manufacturers' Record*, July 21, 1881; American Iron and Steel Association, *Bulletin*, XVIII, 187, July 23, 1884.

[43] *Commercial and Financial Chronicle*, XXXIX, 285–286, Sept. 13, 1884; XLV, 328, Sept. 10, 1887; XLVII, 308–311, Sept. 15, 1888; LI, 329, Sept. 13, 1890; U. S. Department of Commerce and Labor, *Statistical Record of the Progress of the United States, 1800–1907*, 31.

[44] Copeland, *The Cotton Manufacturing Industry of the United States*, 220–221; Chapman, *Foreign Competition*, 171.

yet become a serious competitor with the Occident in the colonial and Far Eastern market.[45]

It is natural, in view of their common sources of raw materials, and to a certain extent their common markets, that a certain synchronism should manifest itself between the alternating periods of prosperity and depression in the American cotton industry and in that of Great Britain. Yet there were certain exceptions to this rule. The protracted depression after the crisis of 1873 was common to both countries. During the four years ending with 1879 it was estimated that British spinners and manufacturers lost in the aggregate well toward $100,000,000. The second depression, which reached its most acute stage in 1884, was also shared by Great Britain and Europe, and there was much talk at this time of an over-expansion of cotton machinery throughout the world. England and America likewise participated in the ensuing revival. But while British spinners were very prosperous in 1891, a brief reaction occurred, as we have noted, in the United States. On the other hand, the temporary recovery in this country just before the panic of 1893 was not shared by England, where the slowing down of all industry was already marked.[46]

RÉSUMÉ OF PROGRESS

Between 1870 and 1890 the number of cotton manufacturing establishments reported in the census declined from 956 to 905. There had been over 1,200 in 1840, when the United States had less than one-sixth as many spindles as half a century later. During these twenty years the number of spindles and looms in the country practically doubled, and the capital invested in the industry increased over 150 per cent; but the number of employes rose less than 64 per cent and the value of product only 51 per cent. The last figure was influenced by the return from an inflated paper to a sound specie currency, and capitalization was so differently defined in successive enumerations that the totals given are only loosely comparable. Nevertheless these statistics record with sufficient clearness the steady expansion of the industry despite the vicissitudes which some of its branches occasionally experienced, the constant drift toward larger establishments common to most lines of manufacturing, and the diminishing part played by the operative and the growing part played by machinery in the process of production, with its corollary, larger capital per operative and per mechanical unit. Probably also the value of product, if measured by a stable monetary yard-stick, would prove to have risen more than the percentage shows. At least the quantity of goods produced, computed on a basis of cotton consumed, was well toward three times as great in 1890 as in 1870. The same inference is suggested by the fact that the average earnings per

[45] *Commercial and Financial Chronicle*, LV, 529–530, Oct. 1, 1892; LVII, 645, Oct. 14, 1893.

[46] *Commercial and Financial Chronicle*, XXX, 158, Feb. 14, 1880; XXXIX, 539–540, Nov. 15, 1884; XLI, 544, Nov. 14, 1885; LIII, 347–348, Sept. 12, 1891; LVI, 188, Feb. 4, 1893; LVIII, 162, Jan. 27, 1894.

operative—even disregarding the deflation factor—rose 77 per cent during this period.[47]

Cotton manufacturing did not share in the movement toward large consolidations that was so marked a feature of the history of many industries during the late eighties and early nineties. The New England Cotton Manufacturers' Association, formed in 1865, had purely professional interests. Neither was tariff legislation a matter of as constant concern with cotton manufacturers as with their brethern in the wool industry, for example; partly because they drew nearly all their raw materials from domestic sources and for that reason were regarded with a less hostile eye by the cotton farmers of the South, partly because cotton spinning was rapidly extending in the latter region, and partly perhaps because the price of cotton fabrics is a matter of less dramatic moment to the average consumer than the cost of more expensive woolens.

[47] Eleventh Census, *Report on Manufactures, Selected Industries,* 186–187.

CHAPTER XXXVI

THE WOOL MANUFACTURE

RAW MATERIALS

A steady movement toward both geographical and plant concentration characterized the woolen industry between 1873 and 1893. Two important mechanical advances, not unassociated with this tendency, stood out among the numerous technical improvements of the period: the perfection of combing machinery and the substitution of the mule for the spinning jack. The former made it possible to employ the relatively short-stapled wool of the Ohio Valley and the older grazing states of the East in the manufacture of worsteds. The latter resulted in a very large increase in the output of yarn per spindle and in a still greater decrease in labor cost.[1]

With the increased manufacture of combed wool fabrics that accompanied these improvements a change occurred in the raw material requirements of American mills. During these twenty years the local wool clip, raised in the vicinity of the factories, decreased—indeed in some sections it virtually disappeared; pure merino breeds were largely supplanted by crossbred types; imported wools, especially those from Argentina and Australasia, improved in quality on account of better preparation for market; more shoddy and cotton were used in fabrics serving the function and in many instances bearing the name of what had formerly been pure wool goods; and a marked general decline occurred in the price of wool, so that in 1893 identical grades were quoted in the New York market at less than half the price they had commanded, when reckoned in gold, twenty years earlier.[2]

When the length of staple required for combing was reduced from 4 inches to 1.5 inches, as occurred with the improvement of combing machinery mentioned, the finer domestic wools could be used for making worsteds instead of the long Canadian and other foreign wools previously employed. Indeed imported long staples were replaced in these fabrics not only by native wool but also by cotton, which was increasingly used for warps serving the purpose of those previously spun from long-staple Canadian and English fleeces. The so-called territorial wools, from west of the Mississippi, were not used for worsteds. Their poorer grades were spun into carpet filling, though here they competed with coarse wools from Asia and the southern hemisphere, where the rapid extension of railways was con-

[1] Cole, *The American Wool Manufacture*, II, 83–90; *cf.* Levasseur, *The American Workman*, 67, note 36.

[2] Wright, *Wool-Growing and the Tariff*, 348–349; *cf.*, however, *ibid.*, 212–213.

stantly tapping a new zone of pioneer pastoral country. Better grades of Western wools were used in the manufacture of blankets, an industry that flourished on the Pacific coast, and in flannels and other carded fabrics, which still remained important items in the total woolen output. Between 1873 and 1893 the American wool clip approximately doubled, rising the latter year to over 300,000,000 pounds—commercial estimates were 348,000,000 pounds.[3]

It was estimated in 1874 that American woolen mills used over nine pounds of domestic wool for every pound of foreign wool they employed. The amount of cotton worked into predominantly woolen fabrics was almost exactly the same as the amount of imported wool, or somewhat over 17,000,000 pounds; and the quantity of shoddy employed was about 19,000,000 pounds.[4] Imports of wool fluctuated widely, sometimes nearly or quite doubling between two seasons. They rose to two peaks prior to 1886, once in 1872 when they suddenly mounted to 126,000,000 pounds from 68,000,000 pounds in the previous year, and again in 1880 when they made the still more remarkable leap from 39,000,000 pounds to 128,000,000 pounds. Both of these years witnessed the culmination of a marked, sudden, brief rise in prices. Between 1873 and 1880 imports averaged only a little over 50,000,000 pounds, after which they rose to the neighborhood of 70,000,000 pounds during the next five years, and then suddenly soared above the 100,000,000 pound level to reach, in 1893, 172,000,000 pounds, the maximum for this period.[5]

These variations in imports did not synchronize with changes in the duties on raw wool. Neither did they parallel a rise or fall in the value of wool manufactures imported.[6] They responded rather to market conditions lying outside the direct influence of legislation and foreign trade. Chief of these was the growing geographical differentiation of pastoral and agricultural as well as factory production throughout the world. Before 1890 every important wool manufacturing nation except the United States had become dependent upon other countries and continents for this raw material. America was moving in the same direction, but slowly, because she had large areas of grazing land, and an extensive sheep industry that resisted extinction by foreign competition through tariff laws. Nonetheless the process was irresistible. Furthermore wool manufacturing in the United States had reached a point where mills called for a greater variety of fibers than the domestic clip could supply. This had long been true of the carpet manufacture, which received a large share of its wool from Argentina, Turkey, Russia, China and other countries where sheep were not scientifically bred or managed. Such coarse wools, which no American

[3] Wright, *Wool-Growing and the Tariff*, 335–336; *cf.*, however, Cole, *The American Wool Manufacture*, II, 65–66.

[4] National Association of Wool Manufacturers, *Bulletin*, V, 221, Jan. 1875.

[5] Wright, *Wool Growing and the Tariff*, 209–211, 340–341; *cf.*, however, Eleventh Census, *Report on Manufactures, Selected Industries*, 31.

[6] Wright, *Wool-Growing and the Tariff*, 344.

grazier could afford to make a business of raising, constituted in normal years two-thirds or over of our total imports and supplied more than three-fourths of the consumption of our carpet factories. Less than 10 per cent of the foreign wools of this class consumed in the United States found their way into other branches of manufacture.[7]

Altogether the relative amount of foreign wool used by American mills increased but slowly; and it was estimated to be 28.5 per cent of the whole quantity manufactured in 1890. Combing wools did not form an important item in these imports, except for a few years in the early seventies, after the worsted vogue set in and before machinery for combing shorter fibers was perfected. But imports of fine clothing wools, or merinos, were growing, this increase being "the most marked characteristic of the industry during the decade ending with 1890."[8] These wools came from Australasia, and were used in combination with domestic fleeces for making worsteds and finer cloths. Manufacturers claimed that they were more regular and uniform than American merinos, as well as "finer, stronger, more elastic, and of greater length of staple." They were also free from the short white hair, or "kemp," that detracted from the value of some domestic wool. To this defenders of American grazing interests objected that in actual practice manufacturers used Australasian wools only when they were cheaper than those raised at home. This was shown by the fluctuation of imports, which did not vary in harmony with the changing quantity of worsteds and other merino fabrics made in the United States.[9] Upon the whole, domestic producers supplied a larger share of the wool consumed by the American people during these twenty years than they did before the Civil War or than they have since. Probably they were in the strongest position in this respect during the middle eighties.[10] But the wool imported before the Civil War entered the country more largely in a manufactured form than it did subsequently.[11]

Wool was by no means the only fiber used in the production of woolen goods. Indeed the degree to which fabrics are sophisticated with cheaper materials measures in a sense the progress of technique in a textile industry. Notwithstanding the fact that the world's wool supply was increasing faster than the population, and wool prices were steadily falling in recognition of this fact, more shoddy, waste and cotton were incorporated in woolen fabrics than ever before. Between 1882 and 1888 imports of woolen rags, shoddy and waste more than quadrupled, exceeding 4,000,000 pounds the latter year. The value of the shoddy produced in the country rose from

[7] Eleventh Census, *Report on Manufactures, Selected Industries*, 31–32; Wright, *Wool-Growing and the Tariff*, 216.

[8] Eleventh Census, *Report on Manufactures, Selected Industries*, 32, 69; National Association of Wool Manufacturers, *Bulletin*, xx, 416–417, Dec. 1890.

[9] National Association of Wool Manufacturers, *Bulletin*, xvi, 203–204, Apr. 1886; Rice, D. H., *Protection of Wool and the Protective Policy in General*, 25; Wright, *Wool-Growing and the Tariff*, 219.

[10] Wright, *Wool-Growing and the Tariff*, 225.

[11] National Association of Wool Manufacturers, *Bulletin*, xx, 418–419, Dec. 1890.

less than $5,000,000 to nearly $8,000,000 within a decade. By 1889 the quantity of substitutes employed in woolen fabrics was supposed to have reached one-third the total. This figure was confirmed by the Census, which showed that shoddy and kindred fibers formed 22.72 per cent and cotton 13.26 per cent of the materials used in the woolen industry. But during the preceding decade the proportion of shoddy had remained practically stationary, although the percentage of cotton had increased.[12] In any case the per capita consumption of pure wool in the United States was estimated to have risen from less than 8 pounds per annum in 1870 to 8.75 pounds in 1890, and was probably higher than in any other country, unless it were the British dominions. Critics of substitutes forgot that only a generation or two earlier a great majority of the American people were clad in satinets, jeans and other cotton-warp textures; and that the progress of shoddy, mungo and their congeners was progress toward at least superficial uniformity in the apparel of all classes of society. Where the gentleman wore broadcloth and the farmer wore jeans in 1820, both wore worsteds in 1890, which were often identical in texture and pattern, though somewhat different in composition.[13]

Among the fibers other than wool that figured more largely in the industry at the close of this period than ever before was mohair, of which over 2,000,000 pounds were consumed, mostly in the manufacture of upholstery goods. Both mohair and alpaca had had an earlier vogue, when they were employed in the production of hard finished luster fabrics for women's dress goods, but output had waned with a change in fashions, and in the case of alpaca did not revive. Camel's hair, which was combed and spun successfully into carpet warps, was a growing article of importation, the quantity used in 1890 exceeding 7,000,000 pounds.[14]

Nearly three-fourths of the wool used by American manufacturers was raised in the country. Most of the domestic combing wools came from the older sheep raising sections of the Ohio valley and the Northern Appalachians, where flocks were bred and managed with considerable care and the farmer made a profit out of his mutton as well as his wool. But the sheep raisers of the West, especially of Oregon and Montana, soon began to produce the same class of cross-bred wools, suitable for worsteds now that combing machinery could handle shorter staples, that already constituted the bulk of the eastern clip. Indeed the rise of the Far West as a wool-producing area of the first importance was one of the outstanding features of this period. So there was a steady progress upward in the average quality of domestic wool. Although the best was no better than the best fifty years before, a larger and larger share of the annual clip came

[12] National Association of Wool Manufacturers, *Bulletin*, XIX, 126–130, Apr. 1889; XXI, 337–338, Dec. 1891; Eleventh Census, *Report on Manufactures, Selected Industries*, 34, 38–39; *Cf. Boston Journal of Commerce*, XXXVIII, 120, 123, May 30, 1891.

[13] National Association of Wool Manufacturers, *Bulletin*, XXI, 337–350, Dec. 1891.

[14] Eleventh Census, *Report on Manufactures, Selected Industries*, 35–36.

under the clothing class. Meanwhile the clip itself more than doubled, rising from 146,000,000 pounds in 1871 to 309,000,000 pounds in 1890, and in the year 1884 attaining a maximum of over 337,000,000 pounds.[15]

TECHNICAL PROGRESS

Between 1870 and 1890 the consumption of wool in American textile mills rose, in round figures, from 200,000,000 to 386,000,000 pounds. The relatively rapid growth of worsted manufacturing, as compared with that of carded fabrics, is indicated by the fact that while the number of cards running in our woolen mills, including those making knitting yarns, declined from 9,224 in 1870 to 8,198 in 1890, the number of combs increased during this period from 261 to 885.[16] Of course, there had not been a positive decline, such as these statistics might suggest, in the manufacture of carded goods. Machinery was on a larger scale and accomplished more in 1890 than it did two decades earlier. But the capacity of combs as well as cards was increasing. Moreover, the variety of worsted fabrics made was much greater at the latter date that at the former, while no similar development of equal importance occurred in the manufacture of carded cloths. To be sure carding machinery continued to improve. During the seventies feeders were devised for supplying wool automatically to the first breaker cards and finishers, thus replacing a hand operation that was often imperfectly performed. Philadelphia appears to have taken the lead of New England in this particular field, the card cylinders there reaching a maximum of 72 inches in length by 1881, and making 125 revolutions a minute, while 40-inch cards revolving 100 times a minute were still regarded as the standard in the latter section. Cards averaged larger in Pennsylvania ten years later than in any other state, but those of maximum dimension were in New York, Massachusetts and New Jersey.[17] According to some estimates the average amount of wool carded by a set of machinery rose nearly 86 per cent between 1870 and 1880. Though doubts may be cast upon the absolute accuracy of such figures the increasing capacity of cards throughout this period is well established.[18]

In 1860 hand combing still prevailed in our few worsted mills, and consequently the United States, with its high labor costs, was fatally handicapped in this branch of manufacture. Then as already narrated the Lister comb appeared, capable of combing mechanically the long wools still used for worsteds, and was followed by the Noble Comb, which combed

[15] National Association of Wool Manufacturers, *Bulletin*, x, 407, Oct. 1880; xvi, 105–106, July 1886; *Textile Record*, v, 51, Feb. 1884; American Iron and Steel Association, *Bulletin*, xxiii, 57, Feb. 27, 1889; Wright, *Wool-Growing and the Tariff*, 238–258.

[16] Eleventh Census, *Report on Manufactures, Selected Industries*, 72, 80.

[17] National Association of Wool Manufacturers, *Bulletin*, ix, 212–213, Oct. 1879; xi, 40, Mar. 1881; xv, 40, Mar. 1885; Eleventh Census, *Report on Manufactures, Selected Industries*, 22–23; Cole, *The American Wool Manufacture*, ii, 86; *Boston Journal of Commerce*, xxx, 24, Apr. 30, 1887.

[18] Eleventh Census, *Report on Manufactures, Selected Industries*, 23; *cf.* National Association of Wool Manufacturers, *Bulletin*, xvi, 83–84, Jan. 1886; *Boston Journal of Commerce*, xl, 296, Aug. 13, 1892.

much shorter staples than could be combed by hand.[19] Both these inventions, and others that preceded and accompanied them, were of foreign origin as was natural in view of the backwardness of the worsted industry in the United States. In 1880 all but 19 of the 288 combing machines in American worsted mills were imported.[20] Ten years later foreign machinery was still the more common in this department. The number of imported and domestic combs reported in 1890 was 544 and 129 respectively. While American machines were still in a minority everywhere, they had their strongest foothold in New England, especially in Rhode Island, where they were in the proportion of three to eight. Philadelphia, which was one of the most important worsted centers of the country, equipped its mills largely with both combs and mules from abroad.[21]

The change from the spinning jack to the mule, which has been recorded in the history of the period immediately preceding 1873, was not completed until after that date; but before the end of the seventies mule-spinning was practically universal except in worsted mills using the English system, where yarns were spun upon spinning frames. To be sure the hand jack, like the custom carding mill and even the spinning wheel, still survived in isolated localities as recently as 1890; but it was no longer a factor in output statistics. Worsted spinning frames, like certain types of worsted combing machines, continued to be imported from England, but the automatic mules used in American mills were mostly the product of local inventors and machine shops.[22]

Between 1870 and 1890 the number of wool spindles in the United States increased from 2,046,000 to 2,793,000, most of the increment being credited to the second decade of this period. On the other hand the increase of looms, which rose from 45,737 in 1870 to 69,658 twenty years later, was remarkably uniform. Presumably the growth in looms and in spindles did not run parallel, partly because many spindles were installed to supply yarns for the expanding knitting industry. Moreover the capacity of looms rose faster than that of other textile machinery. Only about 3,000 hand looms were reported in 1890. Some of these were used for setting up patterns, and the remainder were employed in making carpets.[23]

FABRICS

American mills consumed fully double as much wool per spindle as did English mills, partly because they spun coarser yarns, and partly because they made relatively more carded fabrics and fewer worsteds. Carpets also formed a larger fraction of the total output of woolen manufactures

[19] National Association of Wool Manufacturers, *Bulletin*, IX, 280, July 1879.

[20] Tenth Census, *Report on Manufactures*, 974.

[21] Eleventh Census, *Report on Manufactures, Selected Industries*, 117; *cf.*, however, *ibid.*, 24.

[22] Eleventh Census, *Report on Manufactures, Selected Industries*, 25–26; National Association of Wool Manufacturers, *Bulletin*, V, 355, Apr. 1875; *Boston Journal of Commerce*, Feb. 27, 1886; Cole, *The American Wool Manufacture*, II, 88–91; XXVII, 195.

[23] Eleventh Census, *Report on Manufactures, Selected Industries*, 26, 73.

in America. Furthermore despite the progress of the last two decades, the industry as a whole was still immature compared with the older manufactures across the Atlantic. America did not provide opportunities for textile education equal to those abroad; she lagged behind Europe in pattern designing and dyeing; her manufacturers had fewer facilities for specializing in finer fabrics, and import duties on raw materials limited to some extent their choice of spinning staples. But within the compass of the domestic wool supply and the popular market at home they adequately supplied the consumers of the country.[24]

These two limitations, of raw-material supply and markets, were more important in case of the woolen than of the cotton industry because patterns, dyes and subtleties of texture count for more in fabrics used for outer garments than in the more varied uses to which cotton goods are put. So far as woolen machinery was concerned what a German expert, who made a study of American woolen mills at the time of the Centennial Exhibition, said of the status of the industry in 1876 was still substantially true in 1893. After observing that the greater part of the machinery invented in America was "superior to the English, German or French machinery; especially looms for finer work, looms for cotton goods, cassimeres, carpets and for heavy work," he added, "but the series of inventions to complete an American system of spinning machinery is not yet finished."[25] A Bradford expert, who reported on the wool and woolen exhibits shown at Philadelphia summarized his conclusions as follows:

"The Americans excel in their manufacture of flannels, blankets and medium cloths, for which their domestic wool is specially adapted, but in goods made of foreign wool they do not compete successfully with England, and their woolen goods generally are not so clean and well finished."[26]

The general report of the judges upon wool and woolens shown at the Centennial referred to the world-wide decline in the manufacture of broadcloths. In the United States only two New England mills were still making them. The pride of the American exhibit was the display of fancy cassimeres by several eastern factories, whose goods, the report says, "in material, fabrication and design had attained the highest standard of this fabric." These were almost exclusively of domestic wool. Already, however, worsted coatings, which were made for the same purposes and by the same manufacturers as cassimeres and differed from them only in the respect that the cassimeres were made of carded and the coatings of combed wool, occupied a prominent place in the displays. These likewise were chiefly of native merino.[27]

[24] National Association of Wool Manufacturers, *Bulletin*, xxv, 49–59, Mar. 1895.
[25] National Association of Wool Manufacturers, *Bulletin*, vii, 165, Apr. 1877.
[26] Great Britain, *Reports on the Philadelphia International Exhibition*, i, 111–112.
[27] U. S. Centennial Commission, *Reports and Awards*, v, Group ix, 44, 50–51; National Association of Wool Manufacturers, *Bulletin*, vii, 107, 110–112, Apr. 1877.

But while despite this creditable showing America was still an imitator and pupil of Europe in the manufacture of colored and patterned goods for outer garments, she stood unquestionably on her own merits in respect to flannels, blankets and ordinary carpets. The first of these fabrics was relatively more important in domestic economy than it is today, for the knitting machine had not yet supplanted the flannel loom for making materials for undergarments. In 1876 blue flannel was exclusively employed for this purpose in both the army and the navy, and since "the regulations of the service require that these flannels shall . . . . . be both wool and indigo dyed," Government requirements "tended to keep alive the skill in indigo-dyeing which, from its costliness, threatened to disappear before cheaper processes."[28] But red was the conventional color of this fabric when made for the civilian market—originally a dull red given by a madder dye and later by lac, and after the Civil War the brilliant scarlet of cochineal, which was still used in the middle seventies, "the price having been reduced to half its former rate by the introduction of aniline dyes." California and Minnesota upheld the reputation of American blanket makers at the Centennial so well that some of those displayed elicited more admiration from the foreign judges present than any other products of our mills. The best California blankets were woven from warps of native wool and filling of Australian wool.[29]

A little attachment used on power looms weaving haircloth at Providence, Rhode Island, illustrates the delicacy of some of the mechanism already employed in American textile mills fifty years ago. This device, which could be enclosed in a box two-inches square, had to pick up one hair at a time, as soon as its predecessor was woven into the web, and insert the end between the warp threads. "To accomplish this, the picker in the machine has a groove or slit invisible to the naked eye, so that the whole of this manufacture turns upon a point which can only be seen with a microscope." Yet so accurately did the apparatus work that one girl attended ten looms employed upon this kind of cloth.[30] In general there is no evidence in the literature regarding the woolen industry called forth by comparisons between domestic and foreign fabrics at the Centennial, and by the presence of visiting manufacturers from the other side of the Atlantic at the Exhibition, to indicate that American mills were not on a par mechanically with those abroad.

Such handicaps as domestic manufacturers encountered were economic rather than technical. For example it was estimated in 1874 that the manufacture of woolens in this country was burdened by a loss of 7.5 to 10 per cent on the cost of its raw materials because there was no local market for the noils, or waste combings, produced in preparing wool for

[28] Great Britain, *Reports on the Philadelphia International Exhibition*, III, 561.

[29] Great Britain, *Reports on the Philadelphia International Exhibition*, 562; National Association of Wool Manufacturers, *Bulletin*, VII, 117–123, Apr. 1877.

[30] Great Britain, *Reports on the Philadelphia International Exhibition*, III, 579–580; National Association of Wool Manufacturers, *Bulletin*, V, 426–428, July 1875.

spinning. These were sold at a heavy sacrifice in America while in Great Britain, with its highly differentiated industry, they brought nearly or fully as much as the scoured wool from which they were combed.[31] A contemporary statement describes the immediate cause of this; the ultimate causes goes back to the fact that foreign mills were producing for a highly diversified export market as well as for a more complex group of domestic consumers than the mills of America.

"In Europe the system of classifying and sorting wools is carried to such perfection, that the wool market is amply supplied with all the distinct sorts; so that the manufacturer may profitably run his mill entirely upon either the finest or lowest sort. From the want of concentration of wool in our market and other causes, the American manufacturer sorts his own wool and, having it of different grades, must make goods of corresponding grades. He can not manufacture properly unless he makes low as well as high-class fabrics. Thus, the products of a single European mill may be superior to those of any single American mill, while the general fabrics of the European may be inferior to the general American fabrics."[32]

Nothing occurred during the next twenty years to modify radically this condition. New fabrics were introduced from abroad from time to time, as market vagaries, passing fashions, or the enterprise of individual manufacturers dictated. In 1880 the bulk of the domestic goods produced were grouped into two classes: 71,000,000 yards of flannels and something over 73,000,000 yards of "cloths, cassimeres, doeskins, diagonals, and suitings." The latter evidently embraced both carded and combed fabrics, which were often made in the same establishment.[33] Jeans still accounted for nearly 30,000,000 yards and satinets for nearly 17,000,000 yards of the country's total woolen output. The former were made principally in Pennsylvania, and they were marketed in large quantities through Louisville to southern and western rural consumers. Satinets remained a New England product, Massachusetts weaving more than three-fourths of all those manufactured.[34]

About 1878, William F. Read of Philadelphia began to manufacture alpaca cloth for umbrella coverings, which had previously been imported, and four years later he introduced in America the manufacture of silk-warp Henriettas and Lansdownes. In fact he was probably the first to make Henriettas in other colors than black, an innovation later imitated by foreign manufacturers. In 1881 the manufacture of mohair plush was established in New England, it is said with looms of American invention, after the promotors of the new industry had failed to learn the secret of foreign machinery, which was kept under lock and key abroad.[35] The same year

[31] National Association of Wool Manufacturers, *Bulletin*, v, 292, Jan. 1875.

[32] National Association of Wool Manufacturers, *Bulletin*, v, 300, Apr. 1875.

[33] Tenth Census, *Report on Manufactures*, 971; National Association of Wool Manufacturers, *Bulletin*, xiv, 295–296, Oct. 1884.

[34] Tenth Census, *Report on Manufactures*, 971–972; *Boston Journal of Commerce*, Sept. 12, 1885; *Cf.* National Association of Wool Manufacturers, *Bulletin*, xiv, 282, July 1884.

[35] Undated letter from William F. Read to Henry G. Kittredge, in *North Papers*; National Association of Wool Manufacturers, *Bulletin*, xii, 241–243, June 1882; xxi, 181–182, June 1891; U. S. Tariff Commission, 1882, *Report*, ii, 1457; Eleventh Census, *Report on Manufactures, Selected Industries*, 58.

the foundations were laid, at Conshokocken, Pennsylvania, of the first mill erected in America to spin worsted yarns on mules by the French system. Hitherto the worsted yarns produced in the United States had been spun on throstle frames as in England, and were hard and wiry. Fabrics woven from such yarns were apt to become shiny with wear, while the softer goods made by the French system were free from this drawback.[36]

Between 1870 and 1880 the number of worsted mills in the United States declined from 102 to 76 but the amount of capital invested and the value of products doubled. During the following decade the number of establishments rose to 143, the capital invested increased more than threefold, and the value of product rose 136 per cent. Meanwhile the number of woolen mills steadily declined and the value of carded products, after remaining about stationary between 1870 and 1880, decreased nearly 17 per cent during the following decade. Nevertheless the quantity of carded goods rose steadily, as measured by the wool consumed in their production. The decline in value was partly explained by the fact that the competition of worsteds tended to limit woolen manufacturers to cheaper fabrics. The same influence probably accounts for the larger employment of shoddy and other adulterants of new wool in this branch of manufacture.[37] The total value as well as the number of square yards of woolen fabrics still far exceeded those of worsteds. In 1890 American mills wove more than 112,000,000 yards of carded cloths and about 114,000,000 yards of flannels, nearly half of which were fancy flannels classed as women's dress goods, besides blankets, shawls and other specialties; while the total amount of worsteds manufactured, including those for women's wear, was in the neighhood of 102,000,000 yards. These figures in both cases embraced cotton-warp fabrics, and in some instances, such as modern printed satinets with mixed cotton and wool filling, goods that belonged to the woolen manufacture by tradition more than by virtue of the materials from which they were made. Of the 74,000,000 yards of worsteds for women's wear included in this total, only 11,000,000 were all wool goods. The latter represented in the main the achievement of American manufacturers since the introduction of the French system of mule spinning eight years before.[38]

[36] National Association of Wool Manufacturers, *Bulletin*, XII, 354–355, Dec. 1882; *Cf.*, *Textile Record*, V, 64, Mar. 1884; *Boston Journal of Commerce*, XXX, 154, July 30, 1887; Cole, *The American Wool Manufacture*, II, 161–162.

[37] Eleventh Census, *Report on Manufactures, Selected Industries*, 50, 55; *cf.*, however, National Association of Wool Manufacturers, *Bulletin*, XIV, 282, July 1884.

[38] Eleventh Census, *Report on Manufactures, Selected Industries*, 50–57.

CHAPTER XXXVII

GEOGRAPHICAL AND TRADE CONDITIONS IN THE WOOL MANUFACTURE

SOME GEOGRAPHICAL ASPECTS

Although this was a period of geographical and plant concentration, and the woolen industry shared in that development, wool continued to be manufactured in a relatively large number of establishments as compared with other textiles. Between 1870 and 1890 those reported in the census declined from 3,209 and 1,693, while the value of products rose, in round numbers, from $199,000,000 to $271,000,000. Meanwhile the number of cotton factories fell from 956 to 905, while the value of their products rose from $177,000,000 to $268,000,000.[1] This decrease in woolen mills was least in New England, which made more than half of the woolen goods produced in the country. It was greatest relatively in the West and South, where the little carding shops and custom mills characteristic of the primitive stage of the industry survived longest. Until 1880 Massachusetts always ranked first among the states in wool manufactures. That year, largely as a result of the rising worsted industry, of which Philadelphia was the most important center, Pennsylvania took the lead in value of product, though not in capital invested. Ten years later Massachusetts still worked up more wool and employed more capital in that business than any other state; but Pennsylvania ranked first in value of products, number of employes and total wages paid.[2]

Price fluctuations affected these monetary measurements. Between 1880 and 1885 the combined product of the woolen and worsted mills of Massachusetts declined in value, although the number of establishments and the amount of machinery increased.[3] This was associated probably with the double swing away from carded fabrics toward worsteds for outer wear and toward knit goods for underwear, which was likewise a swing toward branches of the wool manufacture in which Pennsylvania, as represented by its metropolis, and New York state respectively excelled. Almost half of all the woolen goods made in New York, which ranked third among the states in this industry, were the product of knitting machines.

[1] Eleventh Census, *Report on Manufactures, Selected Industries*, 72–73, 186–187.
[2] Eleventh Census, *Report on Manufactures, Selected Industries*, 16.
[3] National Association of Wool Manufacturers, *Bulletin*, XIX, 263–264, Dec. 1889.

Philadelphia's ascendency in the worsted manufacture was an interesting example of logical sequence in industrial history. From the early days of settlement, when skilled stocking makers and linen weavers settled within or near her borders, her textile manufactures have been stimulated and diversified by successive migrations of operatives from Germany and England. As we have recorded elsewhere, the organization of these manufactures has always resembled that of Great Britain, with its segregation of operations in different establishments, more than has that of Massachusetts, where the typical American system of quantity production in large integrated plants originated. The manufacture of patterned piece goods to order had been a specialty with Philadelphia weavers ever since early in the last century. That city was therefore a yarn market, drawing its supplies from many mills both in the immediate vicinity and at more distant points. The spinning of worsted yarns there began in a small way comparatively early to supply this diversified demand and also to furnish warps for carpet weavers. Gradually this branch of the larger industry developed —at times dovetailing—into other branches, as when looms were shifted from cotton goods to cotton and worsted or all worsted goods with the changing seasons, until large specialized establishments arose, devoted exclusively to worsted combing and spinning.[4] During the middle eighties announcements of new worsted mills were a very frequent news item from Philadelphia and its vicinity.[5] In 1890 eight cities produced about 36 per cent of the woolen and worsted goods made in the United States. Philadelphia led the list with well toward $74,000,000, Providence ranked second with something over $18,000,000, and Lawrence third with just under $10,500,000. Lowell and New York ranked fourth and fifth; but Camden and Chester, which are virtually suburbs of Philadelphia, made between them more woolen and worsted goods than the nation's metropolis.[6]

Wool manufacturing reached its maximum in the central West, so far as the Census records its volume, in 1870, when the total value of its product exceeded $16,700,000, although new enterprises and extensions of old enterprises continued to be reported from that section. Its peak on the Pacific Coast was in 1880, when its output reached $2,254,000. In the South, no decline is recorded, the total value of goods manufactured rising consistently from $4,278,000 in 1870 to $6,700,000 twenty years later. Rather remarkably the premier wool manufacturing state in the South Atlantic and Gulf states group in 1890 was Mississippi.[7]

With all its vicissitudes the woolen industry could count among its establishments several remarkable for their longevity and sometimes for their

[4] National Association of Wool Manufacturers, *Bulletin*, x, 17–33, Jan. 1880.
[5] *Cf.*, *Textile Record*, v, 22–23, Jan. 1884; v, 46, 54, Feb. 1884; v, 74, Mar. 1884.
[6] Eleventh Census, *Report on Manufactures, Selected Industries*, 17.
[7] Eleventh Census, *Report on Manufactures, Selected Industries*, 27, 75, 77, 79; *Boston Journal of Commerce*, XXXVIII, 92, May 15, 1891; *U. S. Commerce and Navigation Reports, 1886*, II, 499–501.

ability to survive under almost static conditions. Some New England mills dated back to the War of 1812. A mill in Ohio that began operations in 1836 was still running with one set of machinery and four looms as recently as 1880. Such mills as the latter, serving exclusively a neighborhood market, survived at the close of the period we are describing,[8] and there were still 193 custom carding mills in the United States as recently as 1890.[9]

The Pacific Coast seemed for a time a promising location for wool manufactures. Wool itself was plentiful, and Chinese immigrants afforded a sufficient supply of operatives. During certain seasons mills had no difficulty in marketing their entire output, especially of blankets, in New York.[10] But capital afforded larger returns in other lines of investment, and eventually Oriental labor was excluded. In fact white operatives were actually the more numerous in both California and Oregon, where there were 102 sets of machinery in operation, even before the exclusion law was enacted.[11] During the eighties the operations of the western mills received considerable attention in the East, partly because of the lower price at which they could obtain their wool. Indeed the margin in favor of the California manufacturer was reported to be at times 22 cents a pound,[12] and California flannels sold as far East as Missouri.[13] But this hopeful condition changed for the worse before the end of the decade. Higher wages, high cost of fuel and high freight rates were against the Pacific Coast manufacturer. In fact wool from California ranches was sometimes carried to Boston for less than the cost of transportation to woolen mills within the state.[14]

FACTORS AFFECTING PROSPERITY

Contemporary testimony as to the prosperity of the woolen industry at any particular date is almost invariably associated with the perennial controversy over duties upon wool and its manufactures. The reason why this should be so was explained in a public statement, issued by the National Association of Wool Manufacturers, in 1886, where the industry was described as having—

"two essential peculiarities . . . distinguishing it from all other domestic industries." These were, "first, the high duty on the raw material, from which the most important of our other textile industries are exempted, and which constitutes a more important element in the cost of fabrication than in any other American industry; and second, the immensely wide scope of the wool manufacture, the number of absolutely distinct branches, greater than in any other general industry, the infinity of fabrics, styles and patterns in each branch, both old and so newly introduced that the term *novelties* is exclusively applied

[8] *Cf.* National Association of Wool Manufacturers, *Bulletin*, v, 305, Apr. 1875; x, 184–187, Apr. 1880; *Textile Record*, II, 9, Jan. 1881.

[9] Eleventh Census, *Report on Manufactures, Selected Industries*, 13, 158.

[10] Hittell, *Commerce and Industry of the Pacific Coast*, 435–437; *Textile Record*, III, 106, Apr. 1882.

[11] *American Textile Manufacturer*, I, 229, Jan. 1882.

[12] *Textile Record*, IV, 334, Dec. 1883; V, 46, Feb. 1884; Eleventh Census, *Report on Manufactures, Selected Industries*, 27.

[13] *Boston Journal of Commerce*, XXVI, 235, Sept. 26, 1885.

[14] National Association of Wool Manufacturers, *Bulletin*, XXI, 395–397, Dec. 1891.

to woolens; the variation of prices according to style, fashion and quality, and the absence of great staple and ruling fabrics, such as are found in the cotton industry."[15]

Obviously these characteristics influenced not only the tariff factor in the prosperity of manufacturers, but also other factors of a less determinate kind. Caprices of fashion, unseasonable weather, fluctuations in the world market for both raw materials and finished goods, found a more sensitive response in this than in most other industries. Yet there were also certain stabilizing factors, such as the almost universal use of woolens for apparel, which as a primary necessity did not vary widely from year to year. By 1870 the mass of the male population of the United States was clad in ready-made clothing, seven-eights of which was estimated to be made of American cloth.[16] And although fashions held sway in wide fields of manufacture, staple fabrics, that did not vary in style of texture from year to year, were also made in great quantities. Consequently periods of depression or the reverse were apt to be local, or limited to special branches of manufacture; and no such generalizations regarding prosperity and profits are possible for the industry as a whole as may be ventured with respect to the production of iron and steel, or even of cotton fabrics.[17]

THE DEPRESSION OF THE SEVENTIES

Naturally the woolen industry suffered, as did all other branches of manufacture, from the crisis of 1873. The hard times were reflected in a larger relative demand for cheap fabrics. By 1876, prices were reported to be fairly stable and the wool clip was increasing. In July 1877, however, the Textile Manufacturers Association of the West held a meeting in Chicago—the first since the panic—where the members reported a continued and increasing depression in business and numerous letters from absentees bore testimony to the discouraging condition of their business.[18]

By 1879 signs of recovery from the depression—or at least the timidity—which had prevailed since 1873 were manifest. Bradstreets reported in the summer of 1880 that the revival during the previous twelve months was so marked that many mills, "especially those in woolens and mixed goods, carpets, hosiery and articles of personal use, never had a better season."[19] This turn for the better followed on the heels of one of the most discouraging periods of the depression; for in the early winter and spring of 1879 mills, that had not stopped during the panics of 1857 and 1873, were obliged to shut-down for lack of markets.[20] But this crisis was not confined to the

[15] National Association of Wool Manufacturers, *The Woolen Tariff Defended and Explained*, (Cambridge, 1886), pp. 12–13.

[16] National Association of Wool Manufacturers, *Bulletin*, v, 298–300, Apr. 1875.

[17] *E.g.*, *Boston Journal of Commerce*, xxxviii, 156, June 13, 1891.

[18] *Commercial and Financial Chronicle*, xix, 486, Nov. 7, 1874; xxi, 619, Dec. 25, 1875; American Iron and Steel Association, *Bulletin*, xi, 212, Aug. 8, 1877.

[19] Quoted in *American Textile Manufacturer*, i, 107, June 1880.

[20] National Association of Wool Manufacturers, *Bulletin*, ix, 111–112, Apr. 1879.

United States. It was world-wide and even more acute in Great Britain, whose wool consumption fell off two-fifths and where recovery was not as prompt as in America.[21] Indeed, as we have seen, the industry in the United States made fair progress during the decade despite these temporary periods of setback.

THE TARIFF OF 1867

The tariff of 1867, which inaugurated a system of compound duties, giving the manufacturer a theoretically fixed margin of protection above the import tax he paid on his raw wool, remained in force, subject to a slight pro rata reduction on both wool and its manufactures between 1872 and 1875, for sixteen years. In practice this tariff effectively shut out foreign fabrics of a cheaper grade, just as the minimum valuation upon cotton goods in the Tariff Act of 1816 excluded foreign drills and sheetings. The effect on domestic industry, though produced by somewhat different procedures, was virtually the same in both instances. The wool tariff of 1867 established specific duties on woolen manufactures about four times as high as the specific duties on an equal weight of wool, plus an additional ad valorem duty as purely manufacturing protection. This was on the theory that it took four pounds of the greasy mestiza wool then chiefly imported to make one pound of cloth. But that ratio did not obtain in coarser fabrics, or in the great variety of cotton-warp cloths and other mixed goods that went under the name of woolens. The immediate effect of this law was to cause a sharp curtailment of wool imports, as noted in an earlier chapter, but it caused a far less marked reduction in the importation of wool in manufactured forms. Indeed the years immediately following the law's enactment were a period of diminished prosperity in the woolen industry compared with the great activity earlier in the decade. But imports of blankets and flannels, which had never been large, practically ceased. Meanwhile Australian wools, which were hardly known in the American market when the Act of 1867 was passed, acquired importance, imports jumping from 1,000,000 pounds to 12,000,000 pounds within a single season. This wool was equal or superior to the domestic, and shrank but little in washing and manufacturing compared with the mestiza wools from South America.[22] It was not only a factor encouraging the expansion of the worsted industry, but it was also used with native wools in heavy carded fabrics, where its slight shrinkage gave the manufacturer a high-duty margin of protection in excess of the amount added to the cost of his raw materials by the tariff.

The law of 1867 never had the full endorsement of the fine wool manufacturers, however, who preferred free raw materials to any compensatory duties conditional upon a tariff-restricted wool market. Their products

[21] National Association of Wool Manufacturers, *Bulletin*, x, 55–58, Jan. 1880.

[22] Wright, *Wool-Growing and the Tariff*, 197–199, 219, 235, 341; U. S. Tariff Commission, 1882, *Report*, II, 1639–1640; Cole, *The American Wool Manufacture*, II, 7–28; Taussig, *Tariff History of the United States*, 201–218; 234–235.

received a minimum of protection from specific duties based upon the weight of imported goods. In fact the tendency of the tariff during the sixteen years from 1867 and to 1883 was to encourage the production of heavy, coarse fabrics, which had long previously been made to advantage in America, rather than the development of new and finer branches of manufacture.[23]

THE FLUCTUATIONS OF THE EIGHTIES

In the Tariff Act of 1883 an effort was made to promote finer and more diversified wool manufactures by levying increased duties upon higher grades of cloths and dress goods. At the same time slight reductions were made in the duties on wool, and larger reductions in the duties upon coarser and heavier fabrics, which were already beyond danger from foreign competition. The combination of specific duties upon wool and specific compensatory duties upon its manufactures was retained, together with ad valorem duties designed for the special protection of the manufacturing interest; but the old ratio of 4 pounds of wool to 1 pound of cloth was reduced to 3.5 pounds to 1 pound in estimating compensatory duties. These changes were not of paramount importance to American manufacturers, though the uncertainty that attended the discussion and enactment of the new law was probably an unsettling influence for the time-being. But a Treasury interpretation of the clauses of the Act applying to worsted coatings and yarns exposed these branches of the industry to serious foreign competition until the ruling was rescinded by the Secretary of the Treasury in 1889, and the latter action was confirmed by a resolution of Congress the following year.[24]

This was an era of falling prices, for both wool and its manufactures, though the downward movement was not uniform and was attended by occasional sharp reactions. Generally the effect of a sagging raw-material market is to make purchasers of finished goods cautious, and therefore to slaken sales.[25] Such a period of stagnation occurred in 1884 and 1885, and during it the Washington Mills at Lawrence, which were at one time the largest establishment in the world devoted to the manufacture of fancy woolen goods, and represented an investment of $4,000,000, were sold at auction for $222,000. Of course this was not typical of the condition of the industry at that time; but it was a conspicuous example of the vicissitudes sometimes encountered by great and apparently well-established enterprises.[26] Almost simultaneously with the announcement of this sale

[23] National Association of Wool Manufacturers, *Bulletin*, VIII, 240–241, July 1878; XV, 46–47, Jan. 1885; U. S. Tariff Commission, 1882, *Report*, I, 854; II, 2242–2247, 2358–2360; American Iron and Steel Association, *Bulletin*, XX, 129, May 20 and 27, 1885.

[24] Wright, *Wool Growing and the Tariff*, 223–224, 231; National Association of Wool Manufacturers, *Bulletin*, XIV, 19, Jan. 1884; XIX, 40, June 1889; American Iron and Steel Association, *Bulletin*, XX, 124, May 12, 1886; XX, 133, May 19 and 26, 1886; XXIII, 131, May 15, 1889; *Textile Record*, X, 167, June 1889.

[25] *Cf.* Hoff, *Die Industrieentwickelung im Bezirk Aachen*, 62–63.

[26] American Iron and Steel Association, *Bulletin*, XVIII, 245, Sept. 24, 1884; XIX, 161, June 24, 1885.

the *Boston Commercial Bulletin* asserted that "the woolen manufacturing interest is in better condition today than most other branches of industry in the United States."[27] A year later a million-dollar mill in Vermont shut down, to resume operations three years subsequently under an owner who had bought the property for about 8 per cent of its original cost. A series of spectacular mill failures in 1889 were said to have had "a benumbing effect upon the wool market."

In appealing to Congress for higher duties, in 1890, the National Association of Wool Manufacturers declared that "disaster in the woolen industry has crowded the seven years since the [tariff] revision of 1883."[28] Undoubtedly worsted manufacturers were for a time in real distress on account of foreign competition, although that branch of the industry seems nevertheless to have grown thriftily throughout the decade. Some fine woolens were probably brought in under fraudulent classifications as worsted goods in order to benefit by the Treasury decision admitting the latter at lower duties,[29] but the great majority of American woolen mills, which made staple carded fabrics and mixed goods, were fairly prosperous. And notwithstanding the unfavorable tariff ruling just mentioned, worsted manufactures rose in value from $33,000,000 in 1880 to $70,000,000 ten years later. Although the per capita output of domestic woolens declined slightly, from $5.65 to $5.39, between 1870 and 1890, this was merely a bookkeeping decrease due to falling prices, and was accompanied by an actual increase in goods produced. During the same period, the per capita net imports of woolen manufactures fell in value from $1.07 to $0.74.[30]

THE McKINLEY LAW

In 1890 the McKinley Act increased duties on wool and levied duties on worsteds as well as woolens more satisfactory to manufacturers than those that had been in force since 1883. Compensatory specific duties on finished goods, to offset the duties manufacturers had to pay on imported wool, were continued. To be sure there were still free-wool advocates, especially among New England woolen mill men, and in 1890 they made an attempt to form an association to oppose the National Association of Woolen Manufacturers and its policy of cooperation with wool growers in maintaining the existing compensatory scheme.[31] But on the whole the new law was satisfactory to both the grazing and the manufactur-

[27] American Iron and Steel Association, *Bulletin*, XIX, 155, June 17, 1885.

[28] American Iron and Steel Association, *Bulletin*, XXIII, 140, May 22 and 29, 1889; XXIII, 242, Sept. 4, 1889; National Association of Wool Manufacturers, *Bulletin*, XXI, 202, June 1891.

[29] National Association of Wool Manufacturers, *Bulletin*, XVII, 219, 231–232, 248–249, Sept. 1887; *cf.* Cole, *The American Wool Manufacture*, II, 157–158.

[30] Wright, *Wool-Growing and the Tariff*, 228–229.

[31] American Iron and Steel Association, *Bulletin*, XXIV, 75, Mar. 19, 1890; XXIV, 93, Apr. 2, 1890: *cf. Commercial and Financial Chronicle*, XLVI, 339–340, Mar. 17, 1888; National Association of Wool Manufacturers, *Bulletin*, XXXIII, 4-7, Mar. 1903; U. S. Committee on Ways and Means, *Hearings*, 51st Cong., 1st sess., 164–179.

ing interests, and in 1892 the National Association of Wool Manufacturers, in arguing against a revision of the McKinley schedule, called attention—

"to the extraordinary development of the wool manufacture of the United States during the thirty years in which the compound system of adjusting the wool and the woolen tariff has been in existence. . . In 1860 our wool manufacturers consumed 85,334,896 pounds of greasy wool, of which 30.4 per cent was imported, a per capita consumption of 2.7 pounds. In 1890 their consumption had grown to about 400,000,000 pounds, of which 26 per cent was imported, a per capita consumption of 6.5 pounds. . . In the ordinary wear of our people the domestic manufacture can now easily supply their entire wants, and with fabrics which for durability and general excellence are nowhere surpassed. In 1860 the British manufacture was consuming 300,000,000 pounds of wool annually, nearly four times as much as our own. In 1890 the British manufacture consumed less than 470,000,000 pounds, or but 15 per cent more than our own. In these thirty years our manufacturing consumption of wool has increased 375 per cent, while that of Great Britain has grown but 57 per cent."[32]

Worsted imports declined after the enactment of the McKinley law and some British manufacturers, adopting the same policy as the Welsh tinplate makers at the same time, erected mills in the United States in order to hold their American market. Certain German exports of fine woolen fabrics to this country also exhibited a marked decrease.[33]

PRICES

Prices of wool and woolens declined during the thirty years following the Civil War, both in sympathy with the lowering of the general price level during post-war and post-panic deflation, and also on account of special conditions common to all wool-producing and wool-consuming countries. One influence operating in this direction was the simultaneous expansion of the world's supply of wool and of cotton. The first was caused by the development of new grazing areas in Asia and the Southern Hemisphere, as well as by the increase of flocks in the United States; the second was due to the recovery of the South and the steady growth of the American cotton crop. Mechanical improvements lowered the cost of producing woolen goods, and cheaper financing and better mill and trade organization contributed to the same result. Currency prices of woolens appear to have been little if any higher in 1870 than gold prices had been in 1860.[34] Fabrics of identical brand and origin were uniformly lower in 1882 than in 1860, the maximum reduction in case of woolen hosiery, where improved machinery came prominently into play, being nearly 40 per cent. The same trend

[32] Memorial of the National Association of Wool Manufacturers, quoted in American Iron and Steel Association, *Bulletin*, XXVI, 18, Jan. 20 and 27, 1882.

[33] American Iron and Steel Association, *Bulletin*, XXV, 50, Feb. 25, 1891; XXVI, 196, July 6, 1892; Hoff, *Die Industrieentwicklung im Bezirk Aachen*, 64, 72; *Boston Journal of Commerce*, XXXVIII, 28, Apr. 18, 1881; *Boston Journal of Commerce*, XXXVIII, 332, Aug. 29, 1891; XXXIX, 248, Jan. 23, 1892; Cole, *The American Wool Manufacture*, II, 163.

[34] American Iron and Steel Association, *Bulletin*, IX, 372, Dec. 17, 1875; XVI, 33, Feb. 1, 1882.

downward was continued even during the period of active business that intervened between 1890 and 1893. The only exceptions to the rule were a few fabrics like broadcloths, that were no longer manufactured on a large scale, but merely in quantities sufficient to supply a restricted and largely non-competitive market.[35] Irregular wool prices due to the effect of the Baring failure and the ensuing financial stringency abroad, which forced producing countries like the Argentine to market their clips more precipitately than usual, introduced a note of uncertainty into all dealings in which this material was a factor. But this was not a uniformly depressing influence, and 1892, the year following that failure, was described as one of "remarkable activity." Machinery was increasing rapidly, wool consumption had risen to 475,000,000 pounds per annum and other signs of confidence were in the air.[36]

This condition continued until the summer of the panic year. In April, 1893, "nearly all the woolen and worsted machinery was well employed in the execution of orders for heavy goods." But weak wool prices soon checked buying in the raw-wool market, especially abroad where quotations were higher than in the United States. The prospect of free wool, with the enactment of the new tariff law already foreshadowed, even caused the reshipment of some Australian wools to Great Britain at a loss, in order to forestall a still heavier anticipated depreciation, although mills were as yet fairly busy filling contracts for goods already sold. By September, however, a larger proportion of the woolen and worsted machinery of the country was idle than since the panic of 1857, although few failures were reported on account of the period of prosperity that had immediately preceded. Not only were no new orders coming in, but customers were cancelling orders already given.[37]

ORGANIZATION

Wool manufacturing escaped the contagion of the trust movement that swept over the country during the late eighties and early nineties. Indeed small mills held their own with some advantage over larger establishments, except in the production of staple fabrics where the volume and the character of sales made quantity output possible. In certain localities successive branches of the general manufacture, such as wool-scouring, spinning, weaving and finishing, were carried on increasingly at separate establishments as they were in Great Britain and Europe.[38] Little woolen mills making knit goods and plain fabrics were to be found in smaller towns like Stafford, Connecticut; Rochester, New Hampshire; Bennington,

[35] National Association of Wool Manufacturers, *Bulletin*, XXIII, 210, Sept. 1893.

[36] National Association of Wool Manufacturers, *Bulletin*, XXIII, 14–15, Mar. 1893; *Boston Journal of Commerce*, XXXIX, 104, Nov. 21, 1891; XXXIX, 264, Jan. 30, 1892; XL, 56, Apr. 30, 1892.

[37] National Association of Wool Manufacturers, *Bulletin*, XXIII, 250, 273–274, 311–312, Sept. 1893; American Iron and Steel Association, *Bulletin*, XXVII, 317, Oct. 25, 1893.

[38] National Association of Wool Manufacturers, *Bulletin*, IX, 281, Sept. 1879.

Vermont; and Lisbon, Maine, where they still "retained some features of the household industry." North Carolina had several such mills making blankets from the mixed merino and Southdown wools of the vicinity. In fact the small and moderate sized plant was regarded as more successful, taking the industry as a whole, than the large factory. Some of the best all-wool dress goods made in the country were the product of a mill operating only 24 looms.[39]

Manufacturers were less dependent than formerly on commission merchants and jobbers for the sale of their goods. The remarkable growth of the ready-made clothing manufacture, including both men's and women's garments, changed somewhat the method of marketing cheap and medium fabrics. So many clothing makers now bought directly from the mills that this practice was thought to insure greater perfection and uniformity in the cloths they employed. Nevertheless claims for rebates for imperfect goods seem to have been a grievance with mill men. Yet commission merchants were not driven out of business by this new development; in fact they were often stock-holders in the companies they represented. During the early nineties competition for the orders of the ready-made clothing makers caused manufacturers to lengthen their usual time of credit to these customers, by post-dating bills several weeks or months after deliveries to such an extent that the practice became a serious evil.[40]

America still received most of its patterns for men's wear from London, and for women's wear from Paris. This handicapped domestic manufacturers, though less in respect to medium and cheaper fabrics used by ready-made garment makers than in respect to more costly goods for the custom-tailoring trade. Blankets, flannels, knit garments and similar products, where fashion and finish were less important, did not suffer from this disadvantage.[41]

[39] National Association of Wool Manufacturers, *Bulletin*, IX, 281, Sept. 1879; XXI, 145, June, 1891; *Boston Journal of Commerce*, XXVI, 38, May 9, 1885; XXXVIII, 26, Apr. 18, 1891; *cf. Boston Journal of Commerce*, XLI, 72, Nov. 5, 1892.

[40] National Association of Wool Manufacturers, *Bulletin*, XXI, 136, 144–145, 151, 156–157, 161–162, June 1891; Cole, *The American Wool Manufacture*, II, 136–146.

[41] *Cf. Boston Journal of Commerce*, XXXVIII, 106, May 23, 1891; XXXVIII, 122, May 30, 1891.

CHAPTER XXXVIII

MANUFACTURE OF CARPETS, KNIT GOODS AND CLOTHING

GEOGRAPHY AND ORGANIZATION OF CARPET WEAVING

The manufacture of carpets and that of knit goods are usually associated with the woolen industry, although they employ large quantities of other fibers, both in combination with wool and alone. Carpet weaving, which had received a powerful stimulus, especially in New England and New York, from the American loom inventions perfected about the middle of the century, made marked progress during the two decades we are now describing. Between 1870 and 1890 the amount of capital invested in the industry increased more than threefold, and the value of its product rose nearly 120 per cent. During the latter half of this period the quantity of carpet manufactured increased, in round numbers, from 39,000,000 to 75,000,000 running yards, divided about evenly between ingrains and the different varieties of Brussels.[1] This expansion was due primarily to the growth of the domestic market, and as it was much more rapid than the increase in population, it recorded a rising standard of comfort in the American home.

No other important textile industry was so highly centralized geographically. In 1890 three New England and three Eastern states contained all the carpet mills in the country. Pennsylvania led with 142 of the 173 establishments reported and over 55 per cent of the total product. New York and Massachusetts accounted for most of the remainder, although there were mills also in New Jersey, Connecticut and Rhode Island. In Pennsylvania, moreover, the industry was localized at Philadelphia and its vicinity.[2]

Another characteristic distinguishing carpet making from most other branches of the textile manufacture was the extensive use of yarns purchased from outside spinners. This was due chiefly to the fact that so many carpet mills were in Philadelphia, where manufacturers of other textiles followed the same practice. Yet this custom prevailed also in New England, where factories were larger and there was more integration of processes. But while Pennsylvania makers bought more woolen yarns, as well as more worsted and cotton yarns than they spun in their establish-

[1] Eleventh Census, *Report on Manufactures, Selected Industries*, 60–61.
[2] Eleventh Census, *Report on Manufactures, Selected Industries*, 62, 120–123.

ments, New England makers generally spun their woolen yarns and confined their purchases to the two latter varieties. In 1890 of the 133 carpet mills in the city of Philadelphia only twelve did any spinning whatsoever. Indeed this specialization in weaving seems to have increased between 1880 and 1890, at least so far as preparatory processes were concerned, for there was a marked decline in the number of combing machines reported.[3] But the number of cards and the number of spindles employed in the carpet manufacture proper rose during the decade. In fact the spindles increased from 115,000 in 1880 to 209,000 ten years later, or nearly as fast as total output, and somewhat faster than the number of looms. Meanwhile, however, the transition from hand weaving to power weaving, which had been under way for more than a generation and was not yet completed, had made rapid progress so that the number of spindles required to supply a loom was larger at the later date. In 1880 of the 7,252 carpet looms reported by the census, 3,995 or more than half were still operated by hand. Ten years later when the total number had risen to 11,235 only 2,697, or less than one fourth, were hand looms.[4]

Hand weaving was more common and persisted longest in Philadelphia where there were many little weaving shops operating eight to ten looms in buildings back of their owner's residence and working on orders from larger manufacturers, who often supplied them with the yarns they wove. An enumeration in 1876 indicated that there were 3,517 hand looms and only 592 power looms in the city. During the next four years the number of power looms more than doubled, rising to 1,346. But hand looms, which were improved about this time by the addition of the Jacquard attachment and turned out on an average 500 yards of carpet a month, also increased, rising to 4,132 in 1880. Both the absolute and the relative decline of hand weaving began soon after this date, however, for in 1889 when the total number of power looms in Philadelphia was 7,350, less than 1,000 were operated by hand.[5]

While the history of carpet making in New England and New York is mainly a record of the growth of great factories—indeed the largest carpet factories in the world—owing their success primarily to the possession of patent rights upon weaving machinery, the expansion in Philadelphia was from the small hand-loom shop to the moderate sized power-loom weaving shed. Several large mills were erected in the latter city between 1870 and 1872; but during the next five years fully fifty of the hand-loom weavers of Kensington, where this industry was chiefly centered and where more carpet was manufactured probably than any other equal area in the world, built enlarged establishments and put in power looms, upon which the original

[3] Eleventh Census, *Report on Manufactures, Selected Industries*, 60.

[4] Eleventh Census, *Report on Manufactures, Selected Industries*, 60.

[5] American Iron and Steel Association, *Bulletin*, x, 339, Dec. 20, 1876; xxiii, 33, Feb. 6, 1889; *Textile Record*, i, 66, 68, Dec. 1880; National Association of Wool Manufacturers, *Bulletin*, xix, 116–117, Jan. 1889.

patent rights had now expired. The result was practically to exclude imported carpets, at least of medium and lower grade, and to induce a large migration of skilled weavers from Great Britain to that city. Among these men were some of the ablest English designers, managers and experts in every department of the manufacture and not a few English and Scotch carpet-mill proprietors.[6] The operatives brought with them not only the skill but also the trade-union traditions of their craft and organized in 1880 a "Power-Loom Brussels Carpet-Weavers' Mutual Defense and Benefit Association of the United States" with some 1,300 members, on the model of an older society of the same kind in England. This was probably one of the earliest bodies of this kind to apply for a charter of incorporation.[7]

VARIETIES OF CARPET MANUFACTURED

Most establishments—the larger ones particularly—specialized in the production of a single type of carpet. The original power loom invented by Erastus Bigelow, and perfected by him at Lowell in the forties, wove ingrains, and that type of fabric continued to be the principal product of the Lowell Carpet Company. About ten years later, having developed a loom for weaving Brussels and Wilton carpets during the interval, the same inventor established the Bigelow Carpet Company, which eventually became the largest manufacturer of these carpets in the world. It combined the several processes of worsted spinning, dyeing and weaving in one establishment. During the fifties, power looms for weaving Axminsters and Moquette carpets were invented and perfected by Alexander Smith and Halcyon Skinner, who erected a factory at Yonkers, New York, which in 1893 was reported to be the largest establishment in existence engaged in this industry. It had nearly 3,800 people on its payroll and a capacity of 43,000 yards of Moquette carpet a year, or 90 per cent of all the carpet of this kind made in the world.[8] Eight of the largest factories, of which one was in Philadelphia, produced about half the carpet manufactured in the United States.

Following the inventions just mentioned, three carpet makers at Philadelphia independently and almost simultaneously devised power looms in the late seventies for making Smyrna rugs.[9] Following the Centennial Exhibition the custom of using rugs instead of carpeting the entire floor came into vogue and created a large demand for the new fabric. A marked improvement in colors and patterns began about the same time. In fact if we may accept at face value the complacent report of the judges at the Centennial Exhibition, even at that date, "rival English manufacturers generously admitted that, in the production of Jacquard Brussels, tapestries,

[6] National Association of Wool Manufacturers, *Bulletin*, XIX, 116–117, Jan. 1889.

[7] *Textile Record*, V, 23, Jan. 1884.

[8] National Association of Wool Manufacturers, *Bulletin*, VII, 145–153, Apr. 1877; Committee on Ways and Means, 53d Cong., 1st sess., *Tariff Hearings*, 999–1000.

[9] Eleventh Census, *Report on Manufactures, Selected Industries*, 61; *Cf. Textile Excelsior*, June 17, 1899, p. 5, quoting *Carpet Trade Review*.

Wiltons, and narrow Axminsters we had nothing to learn from them either in design or fabrication."[10] The larger carpet mills in America already had their own designers who were liberally paid. While manufacturers did not claim absolute originality for their patterns, since no such thing was known in the decorative arts, they did claim that American carpet patterns were "as often copied by the English, who are our rivals, as theirs are by us." The old antagonism between importers and domestic manufacturers was ceasing and many importers had become owners or stockholders in American carpet mills. This probably had some effect upon American designs, for importers, familiar with Persian and Indian carpets, the best examples of which often adorned their establishments, introduced their patterns in the mills in which they were interested.[11] Whatever prejudice still existed against domestic carpets from an art standpoint—and it survived for several years after this date—had largely disappeared by the early nineties, when the studios of the Bigelow, Lowell, Smith, Hartford, Higgins and the Philadelphia companies employed some of the best designers, many of whom were Americans, in the world.[12]

IMPORTS AND DUTIES

In 1873 a large proportion of the high-grade carpets sold in the United States were of foreign manufacture, although domestic makers already controlled the market for medium and cheaper grades; but in 1893 our only large imports of this class of goods were of hand-woven Oriental rugs. Even these, although brought to the United States from Turkey and Persia, were sometimes the product of Kensington looms. During the year ending June 30, 1870, Brussels carpets to the value of $1,356,000 were entered at the port of New York alone. Twenty-four years later our entire imports of this class of carpeting were valued at only $58,000.[13] This decline was marked during the seventies, the total imports of carpets falling from $6,000,000 in 1872 to $398,000 six years later,[14] and was coincident with the introduction of the manufacture of Brussels and tapestry carpets in Philadelphia where they were first made by the Dobson's in 1872.

Carpet makers were peculiarly favored by the tariff. The Act of 1867 admitted carpet wool at three cents a pound duty and imposed no higher tax upon washed than upon unwashed wool. This duty was reduced to two and one-half cents a pound in 1882 but was slightly increased—to 32 per cent ad valorem, equivalent to about four cents a pound—by the McKinley Act of 1890. At no time was this tax a serious inconvenience to manufacturers. Meanwhile they were protected by the same combination

[10] U. S. Centennial Commission, *Reports and Awards*, v (Group ix), 75; *cf.* United States Tariff Commission, 1882, *Report*, ii, 2340.

[11] National Association of Wool Manufacturers, *Bulletin*, vii, 145–153, Apr. 1877; x, 67, Jan. 1880; *cf.* U. S. Centennial Commission, *Reports and Awards*, v, Group ix, 66–68.

[12] Depew, *One Hundred Years of American Commerce*, ii, 487.

[13] Depew, *One Hundred Years of American Commerce*, ii, 487.

[14] American Iron and Steel Association, *Bulletin*, xiii, 306, Dec. 3, 1879.

of specific and ad valorem duties upon carpets that were levied upon woolen goods and in their case such duties were practically prohibitory.

MATERIALS, MARKETS AND PRICES

The carpet industry was based almost entirely on the use of imported materials. Of the 55,000,000 pounds of wool spun into carpet yarns by the makers themselves in 1890 only 2,000,000 pounds were of domestic origin. Presumably, though we have no positive statistical proof of this, about the same proportion of the wool represented by woolen and worsted yarns purchased by carpet weavers came from abroad. Among other materials were nearly 24,000,000 pounds of jute, all of which was imported, and nearly 10,000,000 pounds of flax and hempen yarns of which a large proportion was likewise made from imported fiber; neither were Camels' hair, mohair and other materials of minor importance of domestic origin.[15]

Upon the whole the carpet industry enjoyed remarkably uniform prosperity during these twenty years. It seems to have been spared most of the vicissitudes that at one time or another befell the other branches of the woolen industry. To be sure there were occasional periods of overstock. One of these occurred in 1891 and was relieved by an auction held in New York, where within twenty-four hours 60,000 pieces of carpet and 50,000 rugs were sold at an aggregate price of between two and three million dollars, making this the "largest sale that ever took place in the United States." The following season, despite the temporary shortage of carpet wool due to the quarantine imposed on account of the presence of cholera in Europe, the market kept the makers actively employed. This fairly consistent prosperity was maintained in face of steadily falling prices. Between 1876 and 1879 Brussels carpet declined from over $2 to $1.40 a yard and the best ingrains from $1.25 to $0.90. Moquette carpets which sold for $1.55 a ward in 1881 had fallen to $0.90 a yard in 1893.[16] Lower wool prices had something to do with this, but reduced costs of production due to mechanical improvements, the substitution of power for hand labor, large scale production and better business organization, were the principle causes cheapening these fabrics for the public.

By the close of this period the United States manufactured more carpet than any other country in the world. Indeed, we are told that as early as 1879 Philadelphia alone produced more yards of carpeting per annum than did the whole of Great Britain. Although power looms were operated abroad, sometimes under American patents, hand weaving still prevailed everywhere but in America. Indeed, as recently as 1889 only about 5 per cent of the looms in the Leeds district, in England, were operated by power.[17]

[15] Eleventh Census, *Report on Manufactures, Selected Industries*, 120–121; *cf.* United States Tariff Commission, 1882, *Report*, II, 2335–2337.

[16] National Association of Wool Manufacturers, *Bulletin*, VIII, 313, Oct. 1878; U. S. Tariff Commission, 1882, *Report*, II, 2339; U. S. Committee on Ways and Means, *Tariff Hearings*, 53d Cong., 1st sess., 1000, 1005.

[17] American Iron and Steel Association, *Bulletin*, XIII, 306, Dec. 3, 1879; Eleventh Census, *Report on Manufactures, Selected Industries*, 61; U. S. Committee on Ways and Means, 53d Cong., 1st sess., *Tariff Hearings*, 1000.

KNIT-GOODS INDUSTRY

Between 1870 and 1890 the number of establishments engaged in the manufacture of knit goods increased from 248 to 796; the capital invested in the industry multiplied nearly five-fold, and the value of its products rose from $18,411,000 to over $67,241,000. An increasing proportion of cotton and mixtures containing cotton was used in this manufacture as its market widened among the poorer classes of the population. Between 1880 and 1890 the amount of raw wool and woolen and worsted yarn it employed rose in round numbers from 13,000,000 to 32,000,000 pounds, while the quantity of cotton and cotton yarns it consumed increased from less than 28,000,000 to nearly 65,000,000 pounds. These totals do not include knit silk goods, which in 1890 were manufactured to the value of something over a million dollars and represented a new development of the preceding decade. Well toward one-half of the knit underwear made in 1890 was merino, a word that in its application to the knitting industry had lost its original signification of a special grade of fine wool and had become a trade term designating goods made of a mixture of wool and cotton spun together. But by far the greater portion of the hosiery, as well as of the underwear, made in America was manufactured from cotton alone.

The rapid development of this industry, of which there had been a prediction in its growth immediately after the Civil War, was due primarily to an expanding market and improvements in machinery. Occasionally during the eighties a passing fashion stimulated some department of the trade, such as the vogue of Jersey cloth, which is simply a fabric knitted instead of woven. But, upon the whole the growth of the market was uniform; it was largely unaffected by the caprices of fashion; and it was more rapid than the increase of population.

Although this industry was highly concentrated in certain sections of the country, and in many places was integrated in large establishments, the manufacture of some lines of knit goods was still conducted on the household system. Several large firms, reported in the census of 1890 as manufacturers, possessed no factory and employed no power. They bought yarns, which they gave out to women in surrounding towns to be knit at home into such special goods as the market required. Even in case of goods produced largely by machinery a considerable amount of the work of shaping and finishing was still performed by hand.[18]

The Mohawk Valley was the greatest knitting-mill center of the country. Nearly $20,000,000 of the $50,000,000 or more invested in that branch of manufacturing in 1890 was credited to New York State. Pennsylvania ranked second, the center of the industry in that commonwealth naturally being Philadelphia. In fact Pennsylvania reported well toward three times as many knitting machines in 1890 as did New York, or practically two-

[18] Eleventh Census, *Report on Manufactures, Selected Industries*, 65–66.

fifths of all those in the country, although her sister state exceeded her both in capital invested and in aggregate value of product. This was because the establishments in the Mohawk Valley manufactured principally underwear, while Philadelphia manufactured hosiery, a craft preserved there ever since Germantown stockings were sold to Boston and Virginia buyers in Colonial days. About two-thirds of the underwear made in the country was manufactured in New York. Rather more than that proportion of the cotton hosiery was made in Pennsylvania. New Hampshire, although it ranked behind Massachusetts and Connecticut in the knit-goods industry, led all the states in the production of woolen hose and half hose. The business there was concentrated around Winnipesaukee Lake and River as definitely as it was along the Mohawk River in New York. Ohio was also a large producer of woolen hosiery. Most of the Jersey cloth made in America was knit in Philadelphia.[19]

Knitting mills were in operation, however, in all parts of the country. Thirty-two states reported such establishments in 1890. And while the principal knitting centers were in the old textile district between the Schuylkill and the Merrimac Valleys, the industry was also expanding in the Central West, especially in Michigan, Illinois and Wisconsin, where its progress coincided with a relative decline in most other branches of textile manufacturing. The growth in the South came after 1890, although that year North Carolina reported five establishments making cotton hose and underwear.

The outstanding technical improvement of the seventies was the development of the machine invented by Mr. Shaw of Lowell, in 1867, which was the first device to turn out automatically and rapidly seamless goods. His invention was extensively used not only in the United States but also in Europe.[20] During the early eighties many inventors turned their attention toward improvements in knitting machinery, and twenty patents for such devices were granted during the single year of 1882.[21]

Most of the knit goods made in the United States up to the middle eighties or later were what are known as "cut goods" or "half-fashioned goods," that is, the fabric was made on the knitting frame unshaped or partly shaped, and was subsequently cut to pattern and sewed on the sewing machine. The knit goods industry thus differed from other branches of textile manufacturing in adding garment-making with the preceding processes. Full-fashioned products, shaped entirely on the knitting machine, were largely imported, the labor cost of manufacturing them being very much higher relatively to their price than the labor cost of making cut goods. By 1880 there was domestic overproduction of the latter and naturally no importation; but partly fashioned and full-fashioned goods to the value of over $8,000,000 were brought in from abroad.[22]

[19] Eleventh Census, *Report on Manufactures, Selected Industries*, 130–133.
[20] American Iron and Steel Association, *Bulletin*, XXII, 98, Mar. 28, 1888.
[21] *The Textile Record*, IV, 279, Oct. 1883.
[22] U. S. Tariff Commission, 1882, *Report*, II, 2271.

American manufacturers bestirred themselves to capture this market from their European competitors. In 1883 Charles Fletcher, a Providence worsted manufacturer who had migrated to this country from England, began at Thornton, Rhode Island, the manufacture of long full-fashioned cashmere hose for ladies.[23] The same year American machinery for manufacturing full-fashioned goods was developed at Philadelphia.[24] In the field of cheaper products this was a period of temporary depression, especially in the Mohawk Valley; and the Knit Goods Manufacturers' Association recommended a general curtailment of 25 per cent in output.[25] Nevertheless announcements of new knitting mills in the South occurred frequently among the trade items of that year;[26] nor was this period of relative stagnation serious enough to check expansion. During the later eighties and early nineties manufacturers were especially prosperous.[27]

In 1893 the number of knitting mills in the United States had risen to 993, an increase of nearly two hundred within three years. Some of the most notable gains were in the South and West. Improvements in machinery and processes had recently converted the manufacture of ribbed underwear from an experimental undertaking to an established industry of large and growing importance. At the same time real progress had been made in the production of finer goods.[28]

WOOL HATS

Wool manufacturing ramified by easy transitions into other industries. Hat making, like the production of knit goods, ceased to employ wool as its chief material before 1890, and during the ten years preceding that date the number of wool hats manufactured in the country declined. This was due to the growing popularity of other fibers, none of which was novel but which fashion, convenience in manufacturing, and above all cheapness, caused to supplant wool.[29] A wool hat manufacturer testified before the Tariff Commission in 1882 that the duty on imported wool was three and a half times higher than the duty on fur, while a fur hat when finished would bring double the price of a wool hat. In 1874 the patents upon the American machinery that had largely replaced hand labor in hat manufacturing expired. This machinery was introduced abroad, against some resistance on the part of skilled labor, a fact that probably helped to account for the growing imports of the better class of hats about 1890.[30] The manufacture of wool hats was concentrated in the vicinity of Reading, Pennsylvania,

[23] *Bagnall Papers*, II, 951.
[24] *Textile Record*, v, 24, Jan. 1884.
[25] American Iron and Steel Association, *Bulletin*, XVIII, 299, Nov. 19, 1884; *Textile Record*, v, 27–29, Jan. 1884.
[26] *E.g.*, *Textile Record*, v, 55, Feb. 1884; *Industrial South*, VI, 344, July 29, 1886; *Boston Journal of Commerce*, XXXVIII, 252, July 25, 1891.
[27] *Boston Journal of Commerce*, XXXVIII, 69, May 9, 1891; XXXIX, 233, Jan. 16, 1892.
[28] *Cf.*, U. S. Committee on Ways and Means, *Tariff Hearings*, 53d Cong., 1st sess., 748–751.
[29] Eleventh Census, *Report on Manufactures, Selected Industries*, 64.
[30] U. S. Tariff Commission, 1882, *Report*, II, 2543–2544; Committee on Ways and Means, *Tariff Hearings*, 53d Cong., 1st sess., 1171.

where there were some twenty-seven factories. New York, New Jersey and Connecticut were in order named the principal producers of fur hats.[31] Danbury and Bethel, Connecticut, were important centers of this industry, turning out in 1892 more than a third of all the hats made in the United States.[32]

THE CLOTHING INDUSTRY

The wool manufacture was influenced appreciably by the development of the ready-made clothing industry, which, as we have seen, exercised a considerable degree of control over important groups of factory products. Clothing makers not only decided patterns, weaves, finish, and to some extent the materials employed in clothing fabrics for both men and women's wear, but their large purchases stabilized the market for woolen goods, defined its seasons, and in no slight degree determined its outlets. Even the substitution of broad looms for narrow looms was influenced to some extent by their needs.[33] Medium and cheaper grades of woolens were occasionally shipped in the form of ready-made garments to foreign markets where it would have been impossible to sell the fabrics from which the garments were made.

No reliable statistics exist showing the growth of the ready-made clothing industry prior to 1890, for the census figures combine returns from custom tailors and dressmakers with those from clothing factories. But the growth must have been very rapid, for according to these returns, the total quantity of men's clothing, including both custom-made and ready-made garments, produced in 1870 was $147,650,000, while by 1890 the factory product of men's clothing alone was over $251,000,000. In case of women's apparel, which was made in the home to a greater extent and until more recently than male attire, the increase was even more rapid, rising from less than $13,000,000 in 1870, when the figures recorded the product of dress-making establishments as well as factories, to over $68,000,000 in 1890 for the product of factory-made garments alone. New York City was the greatest single center of this industry. But in practically every city of first rank in the United States the statistical records of this distinctively urban manufacture ran into large figures. Most high-grade clothing was made in the East. Cities along the Ohio and Mississippi turned out cheaper garments in which jeans were the standard material.[34] On the Pacific Coast, especially at San Francisco, Chinese labor was at one time an important factor in the industry.

MACHINERY AND ORGANIZATION

While the sewing machine, the most revolutionary piece of mechanism ever introduced in the clothing manufacture, was in common employment

[31] Eleventh Census, *Report on Manufactures*, Part I, 215; *Textile Record*, II, 260, Sept. 1881.
[32] *Boston Journal of Commerce*, XL, 414, Oct. 1, 1892.
[33] Cole, *The American Wool Manufacture*, II, 94.
[34] Memphis Merchants' Exchange, *Reports*, 1883, 29, 1886, 59 and 1888, 66.

before 1873, several important labor-saving devices date from this period. The sewing machine itself was improved and a power drive substituted for the foot treadle. A button-hole machine was perfected; machines cutting cloth for a great number of garments at a time supplanted hand shears; and mechanical pressers relieved the tailor's goose of much of its labor. Some idea of the time saved by these improvements, even when they were not individually remarkable enough to have a history, is conveyed by the fact that within a quarter of a century the output of sewing machines used in the ready-made clothing industry rose by at least one-half. By 1895 the number of stitches per minute had been gradually increased from 800 upon the first foot-treadle machines to 2,800 upon power-driven machines. By hand methods a skilled tailor could make 100 button holes in a day, with a machine a girl could make over 3,000.[35]

The organization of this industry was in a state of almost continuous change, both on account of technical exigencies and the compulsion of manufacturing economies and because of the peculiar labor conditions affecting it. Between 1870 and 1890 this manufacture, at least in the larger centers, fell into the hands of immigrants, most of whom were Jews. The influx of these highly individualistic workers probably tended to preserve the dispersed and quasi-household system of production that had survived from an earlier period. Contractors and the sweat shops supplanted the family as outworker units. Indeed the small shop contractor became the manufacturer proper, while the nominal manufacturer confined himself increasingly to the purely commercial functions of buying raw materials and marketing finished goods.[36] Simultaneously, processes of manufacture were so specialized as to dispense largely with highly skilled workers. Even in what would appear comparatively simple operations, such as the sewing of different seams in a coat, there was a subdivision of labor, the more experienced machine hands sewing the more difficult seams and their helpers the less difficult. Consequently this manufacture tended to concentrate at points of cheapest labor. This helps to explain why so large a share of the clothing manufactured in America is made at New York City, the debarkation point for most of our unskilled immigrants. It was largely for the same reason that the manufacture of certain grades of clothing became established on the Pacific coast. Practically no white labor was employed in the California factories, which were devoted largely to making shirts, cotton underwear, overalls and similar goods. Indeed, it was claimed in 1881 that duck and denim suits made in San Francisco by Chinese workment could be sold at a profit in the eastern states.[37]

The modern model clothing factory is a product of the last quarter of a century and did not play an important rôle in the industry during the period we are now describing. As long as the business of making garments

[35] Pope, *The Clothing Industry in New York*, 25, 75–78.
[36] Pope, *The Clothing Industry in New York*, 50–51, 61, 64–67.
[37] Hittell, *Commerce and Industry of the Pacific Coast*, 452-455.

was let out to contractors and through them to sub-contractors, the actual work was for the most part done in small shops employing ten operatives or less under the direct supervision of their employer. About 1875 English Jews introduced into New York what is known as the team grouping of clothing workers. A team consisted originally of skilled tailors. One of these did the machine work and was known as the operator. Needle work was divided between a baster and a finisher. Operations which could not be placed with a single team, such as pressing, sewing on buttons and making button-holes, were done by other workers. Before the close of this period, a further subdivision had been introduced, by which a team was enlarged to include a second or less skilled operator in each of the three occupations mentioned. A definite limit was placed upon the growth of this group, however, by the difficulty in synchronizing the output of a large number of workers, so that all could keep continuously employed.

A second method was introduced into the United States by English tailors who settled in Boston, whence the name "Boston system," but which was not adopted at New York until after the period we are now describing. This system consisted in a still further subdivision of the work by which a team, instead of making coats, for instance, would make but one part of the coat, such as the collar. This division of labor completely eliminated the skilled tailor.

By a rather odd contrast between quality of skill and quality of product, the standards of clothing making in America advanced *pari passu* with the employment of unskilled foreign workers. In the nineties medium ready-made clothing was as well tailored as the best grade before 1880. This may have been due partly to the fact that with lowered labor costs a slightly more elaborate process of manufacture could be employed. For instance, [illegible] is called in the trade the "open work" process, where linings and outside material are built up together, piece by piece, as is done by a custom tailor, was largely substituted, especially in the better grade of goods, for the "closed system" of putting together the entire lining independently of the outer fabric and uniting the two by a margined seam as almost the final operation in the manufacture of the garment.[38]

[38] Pope, *The Clothing Industry in New York*, 61–75; Depew, *One Hundred Years of American Commerce*, II, 563.

CHAPTER XXXIX

MANUFACTURE OF SILK AND MINOR TEXTILES

RAW SILK

Silk manufacturing made relatively greater progress in America between 1870 and 1890 than any other textile industry, the total value of its product rising from about $12,000,000 to over $87,000,000.[1] No increase of importance was recorded in the domestic production of raw silk, although some hopeful trials were made in California, Kansas, and elsewhere;[2] but the trade in raw silk from the Orient grew rapidly, not only via San Francisco and the trans-continental railways, but also about 1880 via the Suez Canal. In the early days, when our pioneer manufacturers procured their materials mostly via Europe, they had to take the leavings of the market, the most uniform and finest fiber generally remaining in the hands of foreign manufacturers.[3] American mills now had their pick of the raw silk of the Orient, although it was by no means equal to the best from Europe, much of that coming from China, in particular, being carelessly reeled and seriously adulterated. About 1874, however, Japan woke up to the importance of maintaining the reputation of her raw silk in foreign markets. The Japanese government shortly afterward took this matter under its supervision with the result that the raw silk exported by that country immediately improved, and American imports correspondingly increased. Between 1873 and 1877 the value of raw silk received by American manufacturers from China fell from $4,386,000 to $233,000, while the value imported from Japan rose from $240,000 to $4,372,000. China did not meet her slump in exports by improving the quality of her silk but by lowering its price. She thus recovered a portion of her lost market; and in 1880 supplied our manufacturers with well toward $7,000,000 worth of this material, or nearly twice as much as Japan. But this temporary recovery was not maintained, and by 1885 China's exports to America again sank to about $3,000,000 while those of Japan had risen to well over $5,000,000. Meanwhile, however,

[1] Eleventh Census, *Report on Manufactures, Selected Industries*, 3–4; *cf.*, however, Mason, *The American Silk Industry and the Tariff*, 5.

[2] Brockett, *The Silk Industry in America*, 46–47; Committee on Ways and Means, *Hearings*, 51st Cong., 1st sess., 601–603, 639–640; American Iron and Steel Association, *Bulletin*, XVII, 249, Sept. 12, 1883; Mason, *The American Silk Industry and the Tariff*, 34–36.

[3] Wyckoff, *The Silk Goods of America* (1880), 25.

Italy had again established a market for her raw silk in the United States, partly because the best filaments from Europe are somewhat smoother, stronger and more uniform than those of the Orient. Consequently when American manufacturers began to produce more varied and higher class fabrics, they were obliged to resort to European sources for their materials. Indeed, there had always been some imports from France and Italy; and in 1883 the value of the raw silk received from the former country was well over $3,000,000. But Italy rapidly took precedence in this market, partly because American reeling machines were set up there, resulting in an immediate improvement in the uniformity and clearness of the product. The two principal causes for America's swing back from Oriental to European silk were the introduction of the manufacture of plain dress goods and the change from the hand to the power loom. Plain broad fabrics which show every defect in their texture call for peculiarly uniform threads, and the power loom requires a strong thread for its economical operation. Therefore importations of raw silk from Italy later surpassed those from China; but Japan continued to be our principal supplier, sending us about half of all the silk that we received.[4] In 1870 our imports amounted to 584,000 pounds, valued at $3,000,000; in 1890 they had risen to nearly 6,000,000 pounds, valued at over $23,000,000.

America's silk industry owed its existence, in competition with the cheap labor of Europe, to tariff protection and to the employment of improved machinery that enabled manufacturers to dispense in a large measure with the services of skilled operatives. Such machinery could be run successfully only with raw silk of fairly high quality. The same conditions discouraged overloading silk with dyes and adulterants, as was the common practice abroad.[5] Between 1873 and 1880 the so-called standard dye was generally adopted in the United States. This meant adding to the silk a quantity of dye equivalent to the weight of the gum taken out of the raw silk during its preparation for manufacture. In Europe, where highly skilled manual processes were still employed, it was possible almost to double the weight of silk with dyes, sizes and other adulterants.[6]

EXCEPTIONAL PROSPERITY

Silk manufacturing suffered less than any other textile industry from the panic of 1873. Indeed, there seems to have been little or no decrease of employment in this manufacture at a time when other factories and workshops were standing idle. The explanation for this is to be found in the stimulus which the industry received from the opening of a new route to the Orient, the high tariff, the general discouragement of importation con-

[4] Mason, *The American Silk Industry and the Tariff*, 17–30; American Iron and Steel Association, *Bulletin*, XXI, 5, Jan. 5 and 12, 1887; Wyckoff, *The Silk Manufacture*, 63; Eleventh Census, *Report on Manufactures, Selected Industries*, 223.

[5] Wyckoff, *Silk Goods of America*, 18.

[6] Wyckoff, *Silk Goods of America*, 18.

sequent upon the depression and our recent heavy borrowings from Europe, rapid technical progress at home and, last of all, the superior facilities our manufacturers had for supplying promptly popular patterns and accommodating their products to the caprices of fashion. In 1873 when we were manufacturing silk goods to the value of $20,000,000, the largest item was machine twist, which totaled more than one-fourth this amount. Ribbons, trimmings, handkerchiefs and neckties followed in order. Our manufacturers wove broad silks to the value of only a little over a million dollars. Silk mills were in operation in ten states, but more than half the output was credited to New Jersey and New York.[7]

Low and declining prices of raw silk appear to have favored the prosperity of our manufacturers and the years immediately following the panic were such a period. In fact, during 1874 and 1875 quotations of raw silk ruled lower than for twenty years previously.[8] In 1876 New York commission houses hitherto dealing exclusively in foreign silk were seeking consignments from American makers, although the prejudice in favor of French, English and Italian goods was still so strong that American fabrics were often sold under the labels of those countries.[9] Silks were reported to be cheaper in 1876 than ever before in the country's history. Yet while silk manufacturers lowered their terms to meet hard times, they apparently continued to prosper. Although other branches of industry were still seriously depressed, the production of several kinds of silk goods at Paterson actually doubled.[10]

THE CENTENNIAL YEAR

In the report upon silks at the Centennial Exhibition in 1876, John J. Hayes said that in acknowledged excellence our machine twists and sewing silks stood first. No twists were then imported and only enough sewing silk to satisfy the lingering prejudice against domestic products. We had no foreign rivals in spun silk fabrics; we supplied two-thirds of the ribbons sold in America; and within the preceding five years the manufacture of broad silks had been placed on a firm foundation. During the previous season the fabrication of colored and block grosgrain dress silks had been successfully introduced on a large scale. At this time no bolting cloths or velvets were made in this country, though the manufacture of the latter had been attempted some years before.[11]

Later in this year the price of raw silk suddenly rose, quotations about doubling within a short period. Simultaneously distressed foreign manu-

[7] American Iron and Steel Association, *Bulletin*, VIII, 156, May 14, 1874; VIII, 268, Sept. 10, 1874.

[8] American Iron and Steel Association, *Bulletin*, IX, 11, Jan. 22, 1875; IX, 138, May 14, 1875; IX, 153, May 28, 1875; IX, 317, Oct. 22, 1875.

[9] *Commercial and Financial Chronicle*, XXIII, 196–197, Aug. 26, 1876; Wyckoff, *Silk Goods of America*, 14.

[10] American Iron and Steel Association, *Bulletin*, X, 131, May 3, 1876.

[11] U. S. Centennial Commission, *Reports and Awards*, V, Group IX, 95–110; Great Britain, *Reports on the Philadelphia International Exhibition*, III, 596; National Association of Wool Manufacturers, *Bulletin*, VII, 279–280, July 1877; *cf.* Trumbull, *Industrial Paterson*, 215–216.

facturers began to unload stocks in America at low prices. Goods were sold in New York, duty paid, for about the price at which they were held at the place of export. This resulted in a temporary acute depression at Paterson and elsewhere. The Dale Manufacturing Company, which owned the largest silk mill in that city, failed with liabilities of several hundred thousand dollars, though amply secured, on account of the depreciation of the value of its stocks on hand. The rise in raw silk was followed by a continued decline, however, the succeeding season, and a rapid increase in the imports of this material. Mills were well employed and the production of dress silks increased. The general condition of the industry was characterized as steady.[12]

GENERAL PROGRESS DURING THE SEVENTIES

This was a period of increasing geographical centralization. During the seventies several silk manufacturers moved from Boston, Williamsburg, Schoharie and New York City to Paterson, attracted to that city by the skilled labor, admirable water power, proximity to the metropolis and other advantages possessed by this established seat of the industry. Most Paterson firms had warehouses in New York City, and their owners often included importers who supplied both foreign and domestic silk goods to the general trade. In the latter respect the combination of commercial experience and taste with manufacturing initiative already observed in case of fine carpet making was repeated in the silk industry. According to a report of the Paterson Board of Trade in 1876, the silk mills of that city employed 8,000 operatives and produced goods to the value of $6,000,000 yearly.[13]

Reviewing the history of the manufacture during the previous decade in his report for 1880, the secretary of the Silk Association ascribed the progress of the industry, in spite of the prevailing depression and falling prices, to mechanical improvements, the growing trade with China and Japan, the Centennial, the introduction of the power loom in America ahead of Europe, and rapid changes of fashion. By the latter year the ribbons made in America were woven on power looms which had been so improved as to be superior to those of Europe and Great Britain. The result was that American-made ribbons were more uniform than those produced abroad. In explaining the rapid progress of mechanical improvements in America, the Secretary of the Association reported that in Europe the contractor bought his tram and organzine—corresponding to the warp and filling in other fabrics—from one maker, sent it to another establishment to be dyed, and then put it out to be woven to weavers operating their own looms in their homes. Under such a system mechanical improvements were not encouraged. In America all the processes of manufacture were

[12] American Iron and Steel Association, *Bulletin*, XI, 141, May 23, 1877; XI, 341, Dec. 26, 1877; XIII, 129, May 31, 1879.

[13] National Association of Wool Manufacturers, *Bulletin*, VII, 277–279, July 1877.

generally concentrated in single mills under one roof, and many factory owners built their own machinery. Since they used relatively less labor than European manufacturers, the reduction in the cost of raw silk had more effect on the total cost of goods in America than abroad.

By 1880 American mills were producing black dress goods. This was the most difficult branch of silk manufacturing; because in these fabrics every defect is so apparent that threads must be perfectly equal and, to attain this, not only the best machinery but highly skilled labor is required. Manufacturers had improved in the process of spinning silk until the were able to substitute spun yarn for reeled yarn in many fabrics. Our principal progress was in broad-silk weaving. By this time there were 283 silk factories in the country. The number of employes had more than doubled within six years and the value of the product had increased from $20,000,000 to over $40,000,000.[14]

MECHANICAL IMPROVEMENTS

In the middle seventies improved machinery for "throwing" silk, as the process of twisting the filaments from the cocoons into threads suitable for weaving is called, were introduced at Paterson by which the speed of spindles was increased from 3,500 revolutions per minute to 7,000 revolutions without detriment to the product. It was claimed that these machines, some of which contained nearly 7,000 spindles, could turn out double the work per spindle produced by the largest European frames, and that they could be managed by two attendants, one on either side. Winding, which a few years before had cost by piece work a dollar a pound, was reduced to 45 cents, although the operatives earned more than at the previous rates. A Swiss machine recently introduced lowered the cost of warping from 10 to 5 cents. Ribbon looms had been rendered so far automatic that eight could be attended by one girl.[15] Shortly before 1880 spindle speed was increased to 10,000 revolutions per minute, which after experimenting with even higher speeds proved the maximum of economical operation.[16] During the following decade further advances were made in throwing machinery that, as we shall see later, eventually enabled unskilled women and children to displace men in this branch of the industry. The result was to encourage the separation of throwing from other operations requiring more skill, and the removal of that process to points of cheap labor. Many broad-silk and ribbon establishments that had hitherto done their throwing in their own plants, opened annexes in the mining towns of Pennsylvania, where they used the labor of the wives and children of miners who until then had been without industrial employment. This transfer of one op-

[14] Wyckoff, *Silk Goods in America*, 28–30, 37–40, 45.

[15] National Association of Wool Manufacturers, *Bulletin*, VII, 279–280, July 1877.

[16] Tenth Census, *Report on Manufactures*, 932; Eleventh Census, *Report on Manufactures, Selected Industries*, 222.

eration to a new district tended to draw the other branches of the manufacture in the same direction.[17]

Among other mechanical improvements credited to Americans, at this time was what was described as the first practical machine ever invented for testing the strength and regularity of silk thread—a device especially important in the United States where automatic machinery was so largely used and consequently threads able to stand a uniform and definitely known tension were at a premium.[18] As a result of these and other improvements, importations of thrown silks, that is, of silk yarn ready for weaving, rapidly dwindled and ceased to be important shortly after 1890.[19]

Between 1875 and 1880 the number of power looms employed in the silk industry increased from 1,605 to 5,321, of which over 3,000 reported Jacquard attachments;[20] but more than 3,000 hand looms were still in use. By 1890 the number of the latter had fallen to 1747, while the number of power looms in operation had increased to well over 20,000. The respective percentages of hand and power looms in 1880 were 37.21 and 62.79; in 1890 they were 7.74 and 92.26. During the interval power looms for weaving both broad and narrow goods had been greatly improved so as not only to lower the cost of production but also to raise the quality of the fabrics woven upon them. An adaptation of the swivel attachment to the power loom made the latter superior to the hand loom for producing embroidered effects, which hitherto had been regarded as in the special province of the latter.[21]

MOVEMENT TO PENNSYLVANIA

The movement of new industries to the coal and iron towns of eastern Pennsylvania, within a few hours journey of Paterson and Philadelphia, did not begin with the silk industry. Boot and shoe factories, cotton mills and other lines of manufacturing using women and children workers were already drifting in that direction. But the silk mills soon became the most characteristic examples of this migration. One of the first large enterprises of this kind was the Adelaide Silk Mills, which were established at Allentown in 1881, notwithstanding the absence of water power at that city, on account of the advantages of "cheap fuel, three railways, clean water, and idle boys and girls." The same year a silk factory was also started at Reading.[22] In 1885 it was predicted that this would soon be a leading industry in the Lehigh Valley. Some Pennsylvania towns were putting up mills and exempting them for ten years from taxation if the occupants would pay interest on the cost in the mills in lieu of rent with the privilege

[17] Mason, *The American Silk Industry and the Tariff*, 50–51.

[18] *Textile Record*, III, 46, Feb. 1882; IV, 72, Mar. 1883; IV, 161, June 1883.

[19] Mason, *The Silk Industry and the Tariff*, 113–114; Manchester, *Story of Silk and Cheney Silks*, 42.

[20] Tenth Census, *Report on Manufactures*, 932.

[21] Eleventh Census, *Report on Manufactures, Selected Industries*, 221.

me ic n Iron and Steel Association, *Bulletin*, XIV, 178, July 21 and 28, 1880; XIV, 243, Oct. 6, 1880. *Textile Record*, II, 235, Sept. 1881; *American Textile Manufacturer*, I, 167, Oct. 1881; I, 213, Dec. 1881; Trumbull, *Industrial Paterson*, 219.

of purchase at the end of ten years. The wages of girls and boys, who could now be employed in throwing, were less than one-third in these towns what they were at Paterson. One Paterson firm established an annex as far distant as Erie, Pennsylvania.[23]

SILK FABRICS

The progress of silk manufacturing in America led to a large increase in the use of silk in place of worsted for upholstery fabrics and dress trimmings. In 1880, domestic manufacturers furnished more than one-third of all the silk goods consumed in the country. These included two-thirds of the ribbons, practically all of the sewing silk, machine twist and handkerchiefs, and more than four-fifths of the satins. The principal imports were dress silks, ribbons, velvets, and mixed silk and cotton fabrics.[24] An innovation of this period was the manufacture of silk chenille and feather trimmings on power looms, a new departure in which America seems to have anticipated England.[25]

In 1882 the manufacture of silk velvets, which had already been attempted at Philadelphia and in Connecticut, was introduced at Paterson, with machinery imported, against strong foreign opposition, from Great Britain. The inaugurator of this industry in that city was an English manufacturer and pioneer Jacquard loom builder in America, who had established himself at Paterson soon after the panic of 1873.[26] About the same time the manufacture of seal plush or imitation seal-skin was also begun experimentally at Paterson.[27] During the early nineties these branches of the industry achieved considerable publicity. Several foreign firms engaged in them migrated to America, partly in consequence of the McKinley Tariff.[28] But the real pioneers in this branch were Cheney Brothers of South Manchester, Connecticut, one of the largest firms in the United States, who made silk velvets and plushes as early as 1880, and the Dobsons of Philadelphia, also prominent silk weavers, who began the manufacture not much later.[29] The latter were involved in a protracted strike of their plush weavers during the summer of 1881, due to the opposition of the men to the importation of English operatives. The proprietors defended their action by declaring that the Americans were not skilful enough to weave fine velvets. This contest apparently ended with a defeat of the strikers.[30] Several firms that engaged in the manufacture of silk plush about this period either failed or ceased operation, partly, it was alleged, because they

[23] American Iron and Steel Association, *Bulletin*, XIX, 315, Nov. 25, 1885; *Boston Journal of Commerce*, XXVII, 256, Apr. 10, 1886; XXVII, 135, Jan. 16, 1886.

[24] Tenth Census, *Report on Manufactures*, 924–925; *Textile Record*, II, 292, Nov. 1881.

[25] *Textile Record*, II, 27, Feb. 1881.

[26] *American Textile Manufacturer*, II, 135, July 1882.

[27] *Textile Record*, III, 39, Feb. 1882; Manchester, *Story of Silk and Cheney Silks*, 42.

[28] *Boston Journal of Commerce*, XXXVIII, 76, May 9, 1891; XXXVIII, 152, June 13, 1891; XXXVIII, 252, July 25, 1891; XL, 408, Oct. 1, 1892.

[29] *Boston Journal of Commerce*, XL, 280, Aug. 6, 1882.

[30] *Boston Journal of Commerce*, XXXVIII, 124, May 30, 1891; XXXVIII, 284, Aug. 8, 1891; XXXIX, 76, Nov. 7, 1891.

produced inferior goods and partly because seal plushes which had been very fashionable during the late eighties suddenly went out of style and prices fell from 20 to 30 per cent.[31]

During the middle eighties silk manufacturing shared the depression prevailing in most branches of the textile industry. This was attributed in 1883 to impending tariff changes.[32] That year the Wortendyke Manufacturing Company, which had employed more than 2,000 people, passed into the hands of a receiver. Its misfortunes attracted special attention because one feature of the establishment was a model mill village, and we are told that each morning before the failure a procession of country wagons brought to the factory loads of farmers' daughters from within a radius of ten miles.[33] This was also a period of depression in Europe and, despite the sluggishness of the trade in the United States, leading Swiss silk manufacturers were reported to be on the point of removing to this country.[34]

About 1880 the manufacture of silk knit goods began at Philadelphia with the production of mittens, ladies' hosiery and minor specialties. Between that year and 1890 the value of silk manufactures in the United States more than doubled, reaching $69,000,000 at the latter date. Among the important items in this total, not large enough to be recorded separately before, was over $1,000,000 worth of such knit specialties and fabrics. Even more important was $3,000,000 worth of velvets and plushes. There had been little increase in the output of sewing silk and machine twist, which had been among the earliest silk products manufactured in America. The production of dress goods increased nearly four-fold and of ribbons well toward three-fold. In 1889 the high-speed automatic ribbon loom was invented in the United States. Like the improved throwing machinery already mentioned, this machinery enabled women and girls to replace men.[35] This improvement came too late, however, to have much influence upon the figures here quoted. Among the few recessions in silk production was a decline in the value of silk handkerchiefs from nearly $4,000,000 to less than $2,000,000—an example of the influence of fashion on this industry.

The whole silk manufacture experienced an acute depression again in 1890 and 1891. Ribbon makers seem to have suffered the worst, presumably on account of a change of style coincident with mechanical improvements that greatly increased the possibilities of output. But this period of idle or semi-employed machinery was not a long one and by the autumn of 1891 the business was again on a full tide of prosperity.[36]

[31] Committee on Ways and Means, *Tariff Hearings*, 53d Cong., 1st sess., 1023–1035.
[32] *Textile Record*, IV, 161, June 1883.
[33] *Boston Journal of Commerce*, XXVII, 55, Nov. 21, 1885.
[34] *Boston Journal of Commerce*, XXVII, 6, Oct. 17, 1885.
[35] Eleventh Census, *Report on Manufactures, Selected Industries*, 213, 217; Mason, *The American Silk Industry and the Tariff*, 124–125.
[36] *Boston Journal of Commerce*, XXXVIII, 140, June 6, 1891; XXXVIII, 236, July 18, 1891; XXXVIII, 396, Sept. 26, 1891.

SILK DUTIES

No duties were levied upon raw silk during this period; on the other hand, silk manufactures, which were regarded as luxuries by legislators, were subject to a general ad valorem duty of 60 per cent prior to 1883. By the Act of the latter year the general duty was reduced to 50 per cent and duties on thread and on spun silks, which were made at a minimum labor cost on automatic machinery and produced about as cheaply in the United States as anywhere, were simultaneously lowered from 35 to 30 per cent. These reductions had no visible effect upon the prosperity of the industry. In fact the chief concern of silk manufacturers in all tariff hearings seems to have been to prevent fraudulent entries of foreign goods at unfairly low valuations and other evasions of the customs laws. One of the most notable of these devices to defeat the intent of Congress was the entry of silk ribbons as "hat trimmings" at 20 per cent ad valorem, a subterfuge by which foreign manufacturers made considerable inroads into the markets of domestic producers.[37] The result of this was a powerful agitation for a change in the character of the duties so as to place them on something closer to a specific basis. The McKinley Act of 1890 did not alter the existing ad valorem rate of 50 per cent upon dress goods; but it increased those upon laces, embroideries, handkerchiefs, knit goods and articles of wearing apparel made of silk, and imposed a mixed duty ranging from $1.50 to $3.50 per pound plus 15 per cent ad valorem upon velvets and plushes, on the ground that they were new branches of manufacture just struggling into existence.

GEOGRAPHY OF THE SILK MANUFACTURE

New Jersey regularly ranked first in the silk manufacture throughout this period, but in 1880 New York displaced Connecticut in second place, and ten years later Pennsylvania, as a result of the movement of mills into the coal regions, rose to second rank, while New York returned to its former standing as the third state in this manufacture, and Connecticut was relegated to the fourth position. Altogether fifteen states reported silk manufactures the latter year, of which five had but one establishment each. Most of the silk goods made outside the large eastern centers consisted of sewing silk and yarns, trimmings and other small goods such as could be conveniently manufactured on a modest scale in any large city to fill the orders of local dressmakers and milliners. Indeed, even a large manufacturing state like Massachusetts, which was a pioneer in this industry and still continued to hold an honorable position in it, produced mainly sewing silk and ribbons and laces. The effect of mechanical improvements which rendered the processes of manufacture increasingly automatic was to lessen the dependance of the industry upon a skilled labor supply and consequently to favor its dispersion, in response to the inducements of cheaper sites,

[37] Mason, *The American Silk Industry and the Tariff*, 61.

cheaper power, lower wages and lower taxation, to other sections of the country not too remote from metropolitan markets. Freights on raw materials and finished goods were a relatively unimportant influence in determining its location, since raw silk and silk fabrics are articles of high value in proportion to their weight and bulk. But these dispersive influences had only begun to manifest themselves prior to 1893, and the geography of the industry remained substantially what it had been ever since the Civil War.

Dyeing and finishing, though often performed in the same establishment in which silk goods were made, was more largely an outside operation, relatively to the total extent of the industry, than in the cotton or the wool manufacture. Between 1880 and 1890 competition and improved processes reduced the costs in this department at least one-fourth. While prices of chemicals and dye-stuffs remained about the same, it was not necessary to use as large amounts as formerly for a given quantity of goods. Furthermore, the introduction of machinery operated by power made it possible to do mechanically in 1890 what could only be performed by hand in 1880. There were 52 establishments in 1890 devoted chiefly to dyeing and finishing silk goods and yarn, of which 24 were in New Jersey and 21 in New York State.[38]

FLAX MANUFACTURE

At the Centennial Exposition in 1876 the only displays of flax manufactures exhibited by the Americans were linen threads made by the Barbour Company of Paterson, New Jersey and by the American Thread Company of Mechanicsville, New York, and crash toweling and stair-drills made by the Webster Linen Mills at Webster, Massachusetts, and by the Stark Company at Manchester, New Hampshire. In the report upon textiles we are told that "all these articles were useful and excellent in their way, but bore no comparison as evidence of skill and progress with the linen fabrics of Europe."[39]

At this time little flax mills were in operation at a number of other points in the United States, but none of them was of more than local importance.[40] Such a tiny establishment with spinning machinery and a single loom was running at Manchester, New Hampshire. A flax mill at Albany, Oregon, the only one on the Pacific coast, made some 5,000 pounds of linen thread a year. The larger establishments that exhibited at Philadelphia used mainly foreign fiber. Some 4,000 tons of this were imported by our manufacturers annually from Russia, Belgium, Canada and Ireland, while 1,000 tons were of home growth, coming mostly from the northeastern part of New York state.[41] Flax mills were in operation at Schaghticoke, New

[38] Eleventh Census, *Report on Manufactures, Selected Industries*, 231, 235.

[39] United States Centennial Commission, *Reports and Awards*, v, Group viii, 25; Great Britain, *Reports on the Philadelphia International Exhibition*, iii, 526.

[40] *Cf.*, National Association of Wool Manufacturers, *Bulletin*, vi, 78, Apr. 1876.

[41] American Iron and Steel Association, *Bulletin*, x, 245, Sept. 13, 1876; xii, 187, Aug. 14, 1878; Hittell, *Commerce and Industries of the Pacific Coast*, 473.

York, where this business had been conducted since early in the century, and at Greenwich in the same state.[42]

The growing of flax was encouraged by the increasing demand for binding twine and cotton bale cloth, and about 1880 flax production in the United States was supposed to be increasing, but the competition of jute soon interfered with this promise of expansion.[43] In 1882 a number of merchants and manufacturers in the flax and hemp trade organized the American Flax and Hemp Spinners' and Growers' Association, a society which held regular meetings for several years and devoted itself largely to protecting the interests of its members against adverse tariff legislation.[44] At a meeting held at Greenwich, New York, in February 1887, 19 manufacturers were present, 10 of whom were from New York, 4 from Massachusetts, 2 from New Jersey, 2 from Pennsylvania and 1 from Dakota.[45]

Although growing flax for seed was extending, the production of fiber declined from nearly 8,000,000 pounds in 1850 to a little over 1,500,000 pounds 30 years later. In spite of a duty of $20 per ton on undressed flax and $40 on "dressed line" or heckled flax, no high-grade fiber was produced in America, partly for climatic reasons but mainly on account of the high cost of labor.[46] Twenty-seven establishments were reported in 1880 to be engaged in the manufacture of flax, hemp and jute. Five of these were in the state of Massachusetts. But no fabrics except a small amount of linen crash and toweling were made from flax; though, to be sure, in 1890 samples of linen suitings for summer wear manufactured from American flax and hemp were submitted in testimony before the Ways and Means Committee.[47] The only well-established manufactures from this material were shoe thread, sewing threads, twines, carpet yarns and other spindle products.[48]

Some of the largest flax spinning works in America were virtually branches of similar enterprises in Great Britain. William Barbour and Sons of Lisburn, Ireland, were promotors and part owners of Barbour Brothers and Company of New York controlling the Barbour Flax Spinning Company of Paterson, New Jersey, and the Allentown Flax Spinning Company of Allentown, Pennsylvania, which were the largest makers of flax thread in America.[49] In 1881 Finlayson, Bousfield and Company of Scotland, one of the oldest and largest flax manufacturing firms in the world, established large mills at Grafton, Massachusetts, likewise for making linen thread and

[42] *American Textile Manufacturer*, I, 139, Aug. 1880; U. S. Tariff Commission, 1882, *Report*, I, 273; Secretary of the Treasury, *Report on the Revision of the Tariff*, 1886; 105–106.

[43] *Textile Record*, II, 255, Sept. 1881; U. S. Tariff Commission, 1882, *Report*, I, 1145–1146.

[44] American Flax and Hemp Spinners' and Growers' Association, *Report* for 1885, 6–7; *cf.* American Iron and Steel Association, *Bulletin*, XVI, 205, July 26, 1882.

[45] American Flax and Hemp Spinners' and Growers' Association, *Report*, 1887, 39–40.

[46] Whitman, *Flax Culture in the United States*, 28, 42–56; *Commercial and Financial Chronicle*, XLVI, 697, June 2, 1888.

[47] Committee on Ways and Means, *Hearings*, 51st Cong., 1st sess., 569.

[48] *Boston Journal of Commerce*, XXX, 254, Oct. 8, 1887; XXXI, 20, Oct. 22, 1887.

[49] National Association of Wool Manufacturers, *Bulletin*, XXIII, 181–182, June 1893; U. S. Tariff Commission, 1882, *Report*, I, 287.

yarn. The New England mills made thread for the neighboring boot and shoe factories. Marshall and Company, another Scotch firm, owned a mill at Newark, New Jersey, where they made thread and crash.[50] Domestic firms were also engaged in this business, including a few smaller establishments in the West financed by local capital and employing for the most part local materials. Yet even at a point as remote from tide-water as Minneapolis, where a linen mill was established about 1890 with the idea of using flax dressed from the straw so abundantly produced in the prairie states, resorted within a few months to imported fiber.[51] In 1890 only five establishments were reported by the census as producing linen goods, and their total product was valued at less than $3,000,000.[52]

CORDAGE AND BAGGING

The manufacture of cordage and of bagging was a much larger industry and one that grew rapidly during this period. Its principal products, cotton bale cloth, grain sacks and binder twine, were sold directly to the farmers, whose vote made these branches of business a subject of lively interest to legislators. In 1890 cordage to the value of over $33,000,000 and bagging of flax, hemp and jute to the value of nearly $4,000,000 were manufactured in the United States.[53] Kentucky hemp had long since ceased to be the principal raw material employed in these manufactures. Indeed as early as 1869 the crop had declined from 80,000 tons in its era of maximum prosperity to 2,500 tons.[54] Yet there were periods of slight revival later, and about 1890 optimists predicted that the quantity raised would soon reach the large figures of early days on account of the demand for this material for binder twine.[55]

During the seventies jute and jute yarn began to be imported in considerable quantities, first for the manufacture of burlap and bagging and later for binder twine. The increase in domestic consumption rose from 25,000 bales in 1876 to 125,000 bales in 1889. Its chief employment was for cotton baling of which American mills were equipped to make about 70,000,000 yards annually.[56] The manufacture of binder twine was the principal factor in the growth of the cordage industry which, in spite of the occasional employment of domestic hemp already mentioned, was based almost entirely upon the use of imported fibers, of which the chief was sisal from Yucatan. Between 1881 and 1893 the quantity of Manila hemp manufac-

[50] *Boston Journal of Commerce*, XXXI, 20, Oct. 22, 1887; Secretary of the Treasury, *Report on the Revision of the Tariff*, 1886, 108–109; American Iron and Steel Association, *Bulletin*, XX, 2, Jan. 6, 1886.

[51] *Boston Journal of Commerce*, XXXVIII, 72, May 9, 1891; XLI, 156, Dec. 10, 1892; *cf.*, Committee on Ways and Means, *Tariff Hearings*, 54th Cong., 2d sess., II, 1238–1239.

[52] Twelfth Census, *Reports*, IX, 240.

[53] Eleventh Census, *Report on Manufactures*, Part I, 123, 175.

[54] Committee on Ways and Means, *Hearings*, 51st Cong., 1st sess., 540.

[55] Committee on Ways and Means, *Hearings*, 51st Cong., 1st sess., 553–554.

[56] Committee on Ways and Means, 51st Cong., 1st sess., *Hearings*, 541, 544.

tured in the United States rose from 58,511,000 to 90,281,000 pounds; and the quantity of sisal from 38,803,000 to 110,950,000 pounds.[57]

Two opposing influences bore upon the geographical distribution of this industry. Its dependence upon raw materials favored the location of the factories near tidewater and several of the largest establishments were situated, as they continue to be up to the present time, in Massachusetts, which was a convenient receiving point for Manila hemp, Calcutta jute and Mexican sisal. Moreover, certain industries largely localized in the East, such as the manufacture of carpets and linoleum, which is made on a jute base, afforded a market in the immediate vicinity for a portion of their output. Last of all, the traditions of the longshore rope walks persisted in that section. This branch of manufacture employed Manila hemp almost exclusively, sisal, which mildews in water, being suitable only for binder twine. The Pacific coast, lying at one end of the trans-oceanic route from Calcutta and the Philippines, with its local demand for binder twine and bagging, formed a separate district seldom entering into the calculations of manufactures in other parts of the country.[58] A large factory to make bagging by prison labor was installed at San Quentin, California, in 1881.[59] On the other hand, there was the interior district in the immediate vicinity of the grain fields, where no ropes or carpet warps and comparatively little bagging were manufactured, but there was a large production of binder twine. Factories at points like Peoria, Chicago and St. Louis employed sisal hemp brought up the Mississippi from Mexico.[60] Makers of harvester machinery like the Deering's and the McCormick's of Chicago were largely interested in this branch of manufacture, which eventually became practically a distinct business separate from rope making and other departments of the larger industry.[61]

CORDAGE TRUST

This was the only branch of the textile manufacturing, in the broadest definition of the term, where a serious attempt was made to establish a monopoly. The simplicity and standardization of cordage products, and the extent to which they are made from raw materials subject to speculative control, seemed to invite such an undertaking. Besides this, overproduction and periods of unremunerative prices, which makers vainly tried to obviate by pools and similar trade agreements, called for some effective form of market regulation.[62] But even under these favoring conditions the attempt was not a success. The National Cordage Company was organized in 1887 with the idea of reducing the cost of production by combining plants and stabilizing raw material prices by eliminating competition for

[57] Depew, *One Hundred Years of American Commerce*, II, 492.
[58] U. S. Industrial Commission, *Report*, XIII, 113.
[59] *Textile Record*, II, 325, Dec. 1881.
[60] U. S. Industrial Commission, *Report*, XIII, 114, 116, 141.
[61] U. S. Industrial Commission, *Report*, XIII, 152, 160.
[62] Depew, *One Hundred Years of American Commerce*, II, 491.

fiber among manufacturers.[63] Its goal was to acquire all the mills in the country. But despite a valiant effort to accomplish this, which resulted in the Company at one time owning or otherwise controlling forty-nine manufacturing plants in the United States and Canada, the effort to establish a monoply failed. This was partly due to faulty methods of organization. The Company bought all the raw materials for the various concerns which it controlled and sold their products, but the constituent firms preserved their identity and a certain amount of autonomy in operation.[64] This probably kept the Trust from realizing all the economies originally contemplated. Furthermore, the market for binder twine, which represented about four-sevenths of the total cordage output of the country, was seasonal, reaching its apex just before the harvest. This necessitated a large amount of liquid capital which was tied up in goods accumulated in anticipation of the selling season, or was used in distributing them and selling them on time payments. Between 1890 and 1893 the amount of rope and binder twine manufactured by the National Cordage Company annually rose from less than 44,000,000 pounds to the neighborhood of 160,000,000 pounds, obviously a rapidly increasing proportion of the country's entire product; and the problem of financing the season's turnover became correspondingly heavier.[65]

Thus it happened that the money stringency of the panic year found the Company short of ready cash and of credit to perform this service for its constitutent concerns. Simultaneously a large shrinkage occurred in the value of its huge stock on hand, due to an unprecedented decline in the prices of raw fiber and manufactures. Last of all, the Company had not realized the economies it anticipated from eliminating competition in the raw-material market. Enough powerful firms remained outside the combination to run up prices for raw hemp and sisal, the supply of which was strictly limited. The result was the reorganization in the autumn of 1893 of the National Cordage Company as the United States Cordage Company, with a considerable reduction of assets and capitalization and the final disappearance of the latter corporation two years later.[66] At no time did the National Cordage Company actually control more than 60 or 70 per cent of the mill capacity of the country, and the independent concerns included some of the largest and most efficient in the United States.

[63] *Commercial and Financial Chronicle*, LII, 279, Feb. 14, 1891; LIII, 325, Sept. 5, 1891; U. S. Industrial Commission, *Report*, XIII, 117.

[64] *Commercial and Financial Chronicle*, LVI, 753, May 6, 1893; U. S. Industrial Commission, *Report*, XIII, 127.

[65] *Commercial and Financial Chronicle*, LVI, 1058–1059, June 24, 1893.

[66] *Commercial and Financial Chronicle*, LVII, 901–903, Nov. 25, 1893; LVII, 1124, Dec. 30, 1893; U. S. Industrial Commission, *Report*, XIII, 119, 129; Depew, *One Hundred Years of American Commerce*, II, 491–492.

CHAPTER XL

MANUFACTURE OF LEATHER, LEATHER GOODS AND RUBBER

TANNING MATERIALS AND HIDES

Tanning and boot and shoe making were coeval with lumber and flour milling, and with the other pioneer industries pursued by the first English-speaking settlers in America; and since the pioneer period the making of leather and leather goods had prospered and extended relatively as fast as other long-established branches of manufacture. Nevertheless the two decades we are now describing witnessed a great revolution in tanning and an unprecedented progress in the leather-using industries. American leather, as we have recorded elsewhere, was tanned mainly with hemlock bark in the North, with oak bark in the vicinity of the larger cities and in the Central Atlantic states, and with chesnut oak in the South. Tan bark had been a colonial export and an extract of hemlock bark was shipped to Europe in considerable quantities during the period we are now describing. In addition, shortly after the Civil War, when the Morocco leather industry began to assume new importance in America and the premium on gold afforded unusual protection to local producers, the gathering of the leaves of the native wild sumach became a business of some importance in Virginia and the neighboring Carolinas, where a number of mills were established for curing and grinding them into the powder or flour used by tanners.[1] Except sumach from Sicily, which continued to form roughly half of this material used in the United States, our tanners were not dependent on foreign materials except for hides and partially prepared skins, which were imported in large quantities, as they had been for many decades, from Spanish America and Asia. Indeed, tan bark was probably four or five times as expensive in Great Britain as in the United States. By 1885 Massachusetts tanners imported much of their hemlock bark from Canada, though considerable quantities also came from Maine.[2]

Our own pastures and western plains afforded us some 13,000,000 or 14,000,000 cowhides a year and the local production of sheep skins, goat skins and other materials for leather was very large.[3] As the breed of

[1] U. S. Tariff Commission, 1882, *Report*, I, 588–589, 745–747; Committee on Ways and Means, 53d Cong., 1st sess., *Tariff Hearings*, 62; Davis, *The Manufacture of Leather*, 116–119.
[2] Davis, *The Manufacture of Leather*, 39–40, 494.
[3] U. S. Tariff Commission, 1882, *Report*, I, 587; Depew, *One Hundred Years of American Commerce*, II, 496.

cattle improved their hides tended to become thin and elastic so that considerations of quality as well as cheapness caused tanners to look to the more backward countries for heavy skins. The western ranches of the United States and Mexico supplied hides of this character to our inland tanneries, while South America, California and Africa sent them to the great tanneries along the Atlantic coast. India was the principal source of the goat skins used for the manufacture of morocco and fine upper leathers. Besides these more conventional materials other classes of skins had more or less temporary vogue or were tanned for special purposes. Late in the seventies the manufacture of cordovan leather, made from horsehides, was introduced into the United States at a Newark tannery. In the middle eighties kangaroo leather suddenly became popular and there was a heavy importation of these skins from Australia, the number received at Newark, New Jersey, at one time reaching 6,000 a week.[4]

TECHNICAL PROGRESS

Radical improvements were made in tanning processes during these twenty years. The judges at the Centennial Exhibition remarked upon the better methods already developed in America for making hemlock sole leather, so as to lessen the loss of hide material, to shorten the time consumed in tanning, to eliminate part of the waste of gelatine and gluten, and to produce a more compact and durable product. They noted the relative inferiority of the American upper leather shown at the Exhibition, but at the same time commended the rapid advance in the manufacture of morocco leather and the beautiful finish of the specimens displayed. Foreign experts had examined with interest, and some skepticism as to their quality, the American hemlock tanned sole leathers exhibited in Vienna three years before, because these had recently begun to enter European markets. In 1872, 900,000 hides from the United States were marketed in Liverpool, an incident that created something of a sensation in this trade. All comments upon American tanning exhibits at this time refer to the labor-saving machinery invented and used in the United States.[5]

The technical progress of the industry influenced the manufacture of light leathers more than it did that of heavy sole leathers, which formed a distinct branch of the industry. In the middle eighties Philadelphia tanners developed an improvement in the chrome process for treating light leathers—a method originally discovered by a German chemist in the fifties but commercially a failure hitherto because the tannage was not permanent. This discovery speedily raised Philadelphia, which was always an important leather-making and leather-manufacturing city, to the front rank in the production of this article.[6] Simultaneously more scientific methods were

[4] *Boot and Shoe Recorder*, XII, 59, Nov. 30, 1887.

[5] U. S. Centennial Commission, *Reports and Awards*, V, Group XII, 11–12; Great Britain, *Reports on the Philadelphia International Exhibition*, III, 619–620; U. S. Commissioner to the Vienna International Exhibition, *Reports*, I, 334, 335, 375, 406.

[6] Depew, *One Hundred Years of American Commerce*, II, 497; *Boot and Shoe Recorder*, V, 484, July 30, 1884; XX, 107, Feb. 17, 1893; U. S. Industrial Commission, *Reports*, XIV, 315–318.

developed for controlling the use of other tanning materials, the tendency being strongly toward methods that shortened the process of manufacture. About 1880 a Gloversville tanner invented the formula for making Dongola kid, thereby completely revolutionizing the manufacture of that leather and morocco. In 1894 a German tanner, returning from the Chicago Exposition, summarized his impression of the industry in the United States as follows:

> "The best machines in the tanning line are American inventions, the merit of introducing new and valuable tannages, as Dongola and chrome, is exclusively due to the Americans, and every day we hear of new startling improvements and gigantic transactions from over the water."[7]

Parenthetically, Germans were almost as prominent in the tanning industry of the United States as they were in its brewing industry. Several of the men who took a lead in the development of the chrome processes were of German birth or descent. The patentee of an improved method for making glazed kid was born in Hanover; and Milwaukee, one of the greatest centers of the industry and the leading producer of oil-grain leather, owed its prominence in this line of manufacture to German tanners. In fact a trade paper, *Schuh und Leder*, devoted to tanning and leather manufacturing, was published in the German language at Chicago.[8]

The manufacture of morocco leather, as we have just seen, was well established before 1876. It was centered around Philadelphia, Newark, Wilmington and Lynn, in the immediate vicinity of factories making women's and children's shoes. Another light leather also largely employed in the shoe industry was French calf skin which was largely imported up to 1880, but was practically all of domestic manufacture a dozen years later. By the middle eighties nearly all the Russia leather consumed in the United States was made at Philadelphia and in Newark. The manufacture of enameled and patent leathers also made rapid progress, but those imported were preferred, as of better quality than the domestic article, up to the close of the period we are now describing. The growing popularity of lighter and softer shoes added to the market for leathers of this class and encouraged a multiplication of their varieties. Such familiar names, for example, as vici kid date from this period.[9]

GEOGRAPHY OF TANNING

The manufacture of leather was a widely distributed industry, some forty states sharing in its production. The number of establishments declined from 7,569 in 1870 to 1,787 in 1890, although the industry as a whole was

[7] *The Leather Manufacturer*, IV, 160, Dec. 1894.

[8] *Boot and Shoe Recorder*, XVIII, 51, June 18, 1890; XXII, 55, Nov. 16, 1892; *The Leather Manufacturer*, IV, 54, Apr. 1894; IV, 66, May 1894; IV, 77, June 1894.

[9] U. S. Tariff Commission, 1882, *Report*, I, 383, 587, 710; Committee on Ways and Means, 51st Cong., 1st sess., *Tariff Hearings*, 676; Davis, *The Manufacture of Leather*, 66, 67, 70; *Boot and Shoe Recorder*, XI, 27, May 4, 1887; XX, 107, Mar. 2, 1892; XXI, 111, Apr. 27, 1892; XXI, 109, May 18, 1892; XXI, 109, June 1, 1892; U. S. Industrial Commission, *Reports*, XIV, 317.

growing rapidly. During the last decade of this period a remarkable fall in prices, which were at a maximum in 1880 and a minimum in 1890, accounted for a reduction in the cost of materials used from $156,000,000 to $123,000,000 and in the total product from $200,000,000 to $172,000,000.[10] The three states of Pennsylvania, New York and Massachusetts produced more than half of the leather output. Pennsylvania was the leading tanning state, but Massachusetts, where about one-third of all the currying done in the country was performed, led in that particular department of the industry.[11] Certain branches of leather manufacturing were highly localized, such as the production of glove leather at Gloversville, of enameled leather at Newark, of chrome tanned kids and other light leathers at Philadelphia, and of morocco at Philadelphia and Lynn. The manufacture of sole leather was more widely distributed. During the eighties a large number of tanneries making this and other heavy leathers were established in Virginia, Tennessee and other southern states. Philadelphia was reputed to be the greatest leather-making city in the world. Some tanners ascribed this to a peculiar quality of the water there,[12] but the more natural explanation is that it was at the center of an important industrial district where raw materials could be economically assembled and a large portion of the product could be marketed in the immediate vicinity. In 1884 when the 100 establishments in that city were producing leather to the value of $10,000,000 annually, 46 establishments were making morocco, 10 establishments calf kid and glove kid, 9 sheep and fancy leathers, and only 3 were engaged in the manufacture of sole and belting leather.[13] In New England the city of Salem and the adjoining town of Peabody produced large quantities of upper leather for the shoe manufacturers of Lynn, Haverhill and Marblehead.[14] Northern New York was the center for tanning calf skins, but about 1890 the business here suffered an abrupt decline, due to a falling off in demand coincident with the increased employment of lighter leathers, especially vici kid and its equivalents, for shoe uppers.[15] Large tanneries in the principal Ohio Valley cities produced heavy oak-tanned leather for machine belts, harness and saddlery as well as for soles.[16] Chicago had several large tanneries in the vicinity of its packing houses, and Milwaukee was one of the most important leather-manufacturing cities in the country, with a product exceeding that of her larger

[10] Twelfth Census, *Reports*, IX, 704; *cf.*, however, Depew, *One Hundred Years of American Commerce*, II, 495.

[11] Tenth Census, *Report on Manufactures*, 452–453; Eleventh Census, *Report on Manufactures*, Part I, 706–721; Davis, *The Manufacture of Leather*, 74–79.

[12] Davis, *The Manufacture of Leather*, 77; U. S. Tariff Commission, *Report*, I, 589; U. S. Industrial Commission, *Reports*, XIV, 320.

[13] *Boot and Shoe Recorder*, V, 37, Apr. 9, 1884.

[14] Davis, *The Manufacture of Leather*, 493–494.

[15] *Boot and Shoe Recorder*, XIV, 93, Apr. 9, 1890.

[16] *Textile Record*, III, 298, Nov. 1882; *Boot and Shoe Recorder*, XX, 108, Jan. 13, 1892; XXI, 107, Sept. 27, 1892.

neighbor.[17] In spite of the important live-stock industry on the Pacific coast the demand for raw hides from the East was so exigent that California tanners were partly dependent upon those imported. They were able to procure an abundance of tan bark, however, from local sources.[18]

THE LEATHER TRADE

Throughout this period raw hides and skins were upon the free list, while leather was protected according to its varieties by duties ranging from 10 to 35 per cent ad valorem. Exports of leather to Europe, which had begun to attract attention in the early seventies in face of both popular prejudice abroad and the active opposition of European tanners, steadily expanded. To be sure these exports, especially during the years immediately following the Panic of 1873, were the result of stagnant markets and overproduction at home and were said at the time to have entailed heavy losses upon American tanners. Their steady increase, however, indicated that though this might have been temporarily true, it was not a permanent condition.[19] Nevertheless for some years the ratio of leather exports to imports fluctuated widely. For the twelve months ending June 30, 1882, exports exceeded imports by over $600,000; yet during the succeeding twelve months imports exceeded exports by over $1,800,000. But with the development of processes for tanning superior light leathers in America, which made it impossible for European tanners to compete with domestic producers in this line, imports remained stationary or declined while exports rose rapidly; and by 1895 shipments abroad were about double the receipts from foreign makers.[20] One of the principal items in the imports at the close of the period was patent leather, which, as we have seen, Americans had not succeeded in producing of a quality equal to that of the leather made in Europe.[21]

No successful attempt was made to concentrate the control of any branch of the leather manufacture in the hands of a single corporation until 1893, when the United States Leather Company was organized with assets estimated at $42,000,000 and a capitalization of $120,000,000. This company was expected to be the dominant factor in the production and sale of sole and belt leather.[22] Trade associations existed among manufacturers in other branches of the industry, such, for example, as the Morocco Manu-

[17] *Boot and Shoe Recorder*, XVIII, 51, June 18, 1890; Eleventh Census, *Report on Manufactures*, Part II, 141, 341.

[18] Hittell, *Commerce and Industries of the Pacific Coast*, 485.

[19] *Commercial and Financial Chronicle*, XXI, 478, Nov. 20, 1875; XXIX, 396–397, Oct. 18, 1879; National Association of Wool Manufacturers, *Bulletin*, VI, 279–280, Oct. 1876; American Iron and Steel Association, *Bulletin*, XI, 342, Dec. 26, 1877.

[20] U. S. Tariff Commission, 1882, *Report*, I, 585, 587; Committee on Ways and Means, 51st Cong., 1st sess., *Hearings*, 676–679; Committee of Ways and Means, 53d Cong., 1st sess., *Tariff Hearings*, 63; Depew, *One Hundred Years of American Commerce*, II, 497.

[21] *Boot and Shoe Recorder*, XX, 105, Mar. 9, 1892; Committee on Ways and Means, 54th Cong., 2d sess., *Tariff Hearings*, II, 1904–1912.

[22] *Commercial and Financial Chronicle*, 757, May 6, 1893.

facturers National Exchange, but they exercised no administrative control over their constituent firms.[23] An important factor in the industry, however, was the packers, who began to take up tanning on a large scale about 1892, and whose entry into this field of manufacturing probably hastened the appearance of the United States Leather Company the following year.[24]

BOOT AND SHOE MACHINERY

In 1870 boots and shoes to the value of nearly $147,000,000 were manufactured in American factories and in contractor's shops associated with factories. Ten years later, despite the decline of prices due to the deflation of the currency, the output had risen to $166,000,000, and in 1890 it exceeded $220,000,000. Including repairing and custom work these figures were considerably larger. Of the factory product about two-thirds was manufactured in New England.[25]

Mechanical improvements introduced during the ten or fifteen years preceding 1870 were perfected during the following decade so that by 1880 the subdivision of labor in shoemaking had about reached its limit.[26] Thereafter the attention of inventors was directed toward improving the quality of machine-made products rather than toward the subdivision and mechanization of operations, the reduction of costs and the acceleration of manufacture, which had previously been the chief objects in view.

It was logical that the revolutionary inventions in shoemaking machinery should have been conceived and developed in New England, which was already a great center of manufacture by hand processes. The fact that these inventions were made in that section, however, tended to increase and perpetuate its dominance in this branch of manufacture; for the new machines fitted into the factory organization already established there and during the earlier stages of their development they were best adapted to the manufacture of cheap and medium grade goods, which the shoemakers of the Bay State and her neighbors supplied to the rest of the country and in a small way to foreign markets.

Ordinary sewing machines were used soon after their invention for binding uppers and for sewing the light uppers of women's shoes; indeed their employment may help to explain the popularity of serge and cloth shoes for women and children during the sixties and seventies. The next step was so to modify this machine as to enable it to do the heavier work of bottoming or attaching the soles to the uppers. The chief inventions of the years we are discussing were in this field.

To be sure, there were other methods of fastening together the component layers of a sole. This could be done by pegging, for which automatic machinery long since existed, or by the use of metal fasteners or screws.

[23] *E.g.*, *Boot and Shoe Recorder*, v, 116, July 16, 1884.
[24] *Boot and Shoe Recorder*, XXI, 111, Sept. 14, 1892; XXII, 113, Dec. 14, 1892.
[25] U. S. Industrial Commission, *Reports*, XIV, 500.
[26] U. S. Commissioner of Labor, *Thirteenth Annual Report*, I, 113.

FIG. 1.—Bottoming Room in Lynn Shoe Factory of Early Seventies

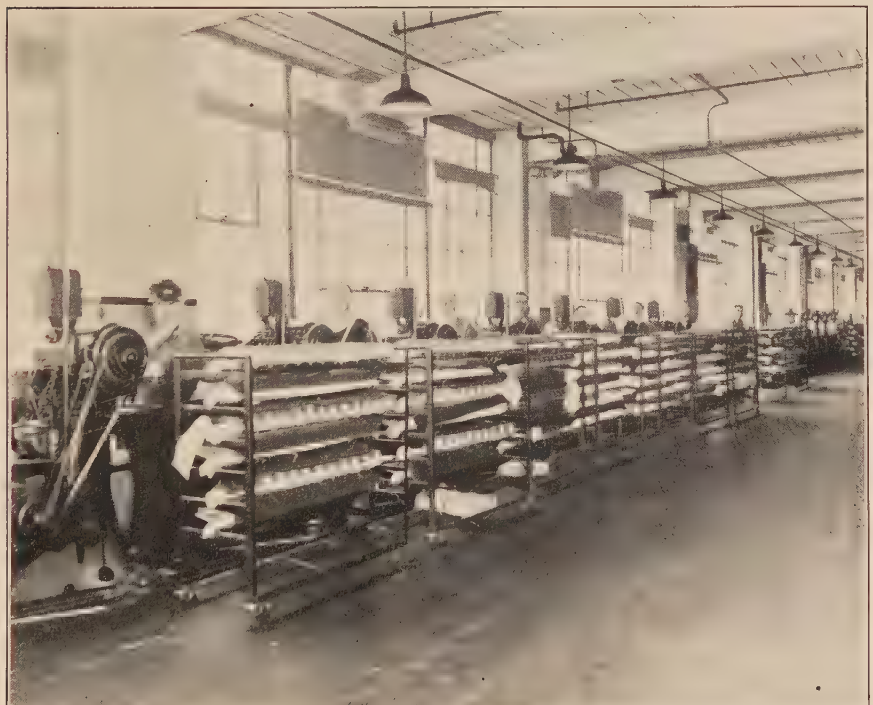

FIG. 2.—Bottoming (Stitching) Room in a Modern Shoe Factory

Courtesy United Shoe Machinery Company

By 1880 three types of pegging machines were in use, the most rapid of which would peg about 900 pairs of shoes a day. While pegging by hand had cost from 4 to 6 cents a pair the standard price for machine work was 50 cents per case of 60 pairs. But by this time the market for pegged work had fallen off, as the demand for coarser manufactures always falls off when better kinds of goods become cheaper, and fewer pegging machines were in use in 1880 than ten years before.[27] The idea of using metal fastenings was brought to America from France, but the machine invented there, which operated by hand and could finish only 25 to 30 pairs of shoes per day, was entirely redesigned in America, where several distinct forms of metal fastening were devised. One type even employed brass encased thread as a sole fastener.[28]

Some heavy goods are still soled by these processes, but the accommodation of the sewing machine to this class of work, and of the structure of the shoe to the sewing machine, has been a much more important feature in the technical development of the industry. The McKay machine, which came into use about 1860, had a monopoly of this field for twenty years. It sewed directly through the outer sole and the insole, leaving a heavy seam on the inside of the shoe which was apt to be uncomfortable for the wearer. Moreover, soles sewed in this manner, though equally durable, were not as flexible as those sewed by hand. In a word, as long as the McKay machine was the only one employed, the effect of mechanical improvements was to cheapen shoes but not to make them more comfortable or to improve their quality. To sew shoes by hand cost at least 75 cents a pair. With a McKay machine the cost was reduced to about 3 cents a pair. Moreover, with this machine insoles could be made of the cheapest kind of leather, or even paper—which was impossible where pegs or metallic fasteners were used, as these required a fair amount of substance to hold them. Before the introduction of the McKay machine a majority of the workmen was engaged in bottoming. After it was perfected a force of seventy-five to a hundred men was required to prepare and finish the work sewed on a single machine. This encouraged manufacturers to give more attention to style and finish and opened the way for the introduction of the other machines at present used in shoe factories. In a word, costs having been reduced to the lowest minimum to which there was a strong economic incentive to force them, the never-ceasing urge toward improvement was turned toward refining and perfecting the product. During the seven years between 1864 and 1870 the number of shoes annually bottomed on McKay machines increased from something over 5,000,000 pairs to more than 25,000,000. This number was estimated to have reached 120,000,000 pairs by 1895.[29]

[27] *Boot and Shoe Recorder*, v, 59, Aug. 6, 1884.
[28] *Boot and Shoe Recorder*, v, 565, Aug. 20, 1884; v, 673, Sept. 10, 1884; IX, 363, May 12, 1886; Twelfth Census, *Reports*, IX, 755.
[29] *Atlantic Monthly*, XL, 669–674, Dec. 1877; *cf.*, *Boot and Shoe Recorder*, v, 431–433, July 23, 1884; v, 541, Aug. 13, 1884; U. S. Industrial Commission, *Reports*, XIV, 482.

Several methods were devised for overcoming the objection to McKay sewed shoes and producing an article that competed in quality as well as price with the hand-sewed products of the custom shop. One of the most promising of these at the time of its introduction seemed to be the Day Process, invented by a Haverhill manufacturer of that name, who after more than seven years of experiment patented and placed in the market a combination system of manufacture, including a machine that split the edges of the insole and temporarily turned back the upper flap and a special last that made it possible to employ a single through and through seam like that of the McKay machine penetrating only half of the insole.[30] But the system that eventually captured the manufacturing market followed closely the method of making sewed shoes by hand, which consists in attaching the upper to the sole by a welt or strip of leather, sewed to the upper and the sole respectively by separate parallel seams, the seam through the sole lying outside the shoe. It was this second seam that made trouble for inventors. The first man to attack the problem seems to have been a Frenchman working as a machinist in New York City, who secured a patent in 1862 for a sewing machine with a curved needle having a circular motion that enabled it to make a seam close to the edge of the upper while in the last. Charles Goodyear jr., a practical shoe man living in New York City, developed this machine with the aid of an English machinist named Daniel Mills, so that, although still imperfect, it was sufficiently advanced by 1869 and 1871 to be employed more or less experimentally in manufacturing.

Numerous modifications and accessory improvements were necessary, however, before the Goodyear system came into general use. The pioneer factories were equipped with it in 1876 and 1877, at a time when the new method embodied the results of the combined efforts of no less than five or six inventors.[31] Nevertheless its adoption was slow, and it was more costly, as it continued to be thereafter, than the McKay system, not only because it necessitated a double seam, but also because it required a better quality of insole and involved the added cost of the welt. At first this system was chiefly employed to make very light goods, such as "turned shoes" and slippers. By 1880 nearly 3,000,000 pairs of these were annually manufactured by this method. At a demonstration in Chicago in 1883, 24 pair of inseams were sewed in 16 minutes and 24 pair of outseams in 25 minutes, the work being declared by competent judges equal to the best hand sewing. During the following decade major improvements continued to be made in this machine and other welt systems of manufacture were invented. The number of Goodyear machines in use increased from 250 in 1880 to ten times that number in 1895; and between 1890 and 1895 the quantity of Goodyear welt shoes made in the United States rose from

[30] *Boot and Shoe Recorder*, III, 65, Apr. 18, 1883; IV, 256, Dec. 5, 1883; IV, 375–377, Jan. 2, 1884; V, 711, Sept. 17, 1884.

[31] *Boot and Shoe Recorder*, V, 743–745, Sept. 24, 1884.

12,000,000 to 25,000,000 pairs.[32] With the extension of this system the manufacture of welting became a separate industry, the welts being made in continuous belts consisting of short strips of carefully selected leather beveled and cemented together and put up in rolls 100 feet long or more. In this form they were distributed not only to American manufacturers but also to foreign countries.[33]

Special machines for rolling soles, cutting outsoles and heels, attaching the heels to the shoe, trimming and polishing heels and performing other minor operations were among the earlier mechanical improvements adopted. But lasting the shoe, or drawing the upper over the last preparatory to attaching the sole, continued to be a hand operation until the eighties. Several machines were invented for performing this operation between 1878 and 1890. Their introduction encountered the active hostility of hand lasters, who were strongly organized; but this resistance was soon overcome, because workmen could actually earn more on the machines than they could at the lasting bench.[34] By this time machinery had shortened and simplified processes until the product of one man's labor was equal to that of a dozen handworkers fifty years before. In some operations, such as sewing the outsoles to the welts, one man with a machine could accomplish as much as fifty-four men working with the awl.[35]

GEOGRAPHY OF BOOT AND SHOE MAKING

While two-thirds of the boots and shoes made in American factories were manufactured in New England, the industry had gained a strong foothold at several important centers outside that area. In 1890 thirty-five states reported establishments engaged in this manufacture. Like most highly developed industries, boot and shoemaking was localized not only in particular towns but in towns devoted to special classes and qualities of goods. No striking change had occurred within several decades in the distribution of the industry as a whole. Lynn remained in 1890 the premier shoe manufacturing city of America, with 323 factories, producing annually goods worth $26,000,000. Brockton, with 73 large factories making more than $16,000,000 worth of shoes and Haverhill with 201 smaller factories making nearly $15,000,000 worth per annum ranked second and third. The concentration of the industry in eastern Massachusetts is indicated further by the fact that Marlborough and Worcester ranked seventh and eleventh respectively among the shoemaking centers of America.

Outside of New England, Chicago was the leading city in this industry, producing goods to the value of more than $7,000,000 annually. This was nearly equaled by Philadelphia and by Rochester, New York. St. Louis,

[32] Depew, *One Hundred Years of American Commerce*, II, 568; *Boot and Shoe Recorder*, III, 299, June 27, 1883; IV, 67, Oct. 17, 1883; IV, 104, Feb. 6, 1884; IV, 547, Feb. 20, 1884; V, 43, Apr. 9, 1884; V, 745, Sept. 24, 1884; XI, 71, Apr. 6, 1887.

[33] *Boot and Shoe Recorder*, XVII, 89, Apr. 9, 1890; XXI, 105, June 15, 1892.

[34] *Boot and Shoe Recorder*, VIII, 75, Oct. 14, 1885; XI, 39, May 25, 1887; XII, 67, Jan. 8, 1890; XVIII, 66, June 11, 1890; XXI, 31–32, July 6, 1892.

[35] U. S. Commissioner of Labor, *Thirteenth Annual Report*, I, 119.

which later became one of the great boot and shoe towns of the United States, stood tenth in rank at this date, following New York and Cincinnati. The predominance of Massachusetts in this industry is sufficiently indicated by the fact that it contained more than half the shoe factories of the Union and produced more than half of the nation's output of boots and shoes.[36]

New York and Pennsylvania were the largest producers of boots and shoes outside of New England. Indeed New York State ranked immediately after Massachusetts in this industry, although it produced less than a fifth as many goods as its neighbor. California, where Chinese labor was employed in this manufacture, ranked eighth among the states. During the early eighties the approaching decline of New England's boot and shoe manufactures was predicted on account of growing competition in the West. But so far as there was an actual transfer of manufacturing enterprises from one section to another, the movement was probably in the opposite direction.[37] New inventions tended to place different sections of the country on a more equal footing so far as operative labor was concerned, because skilled operatives such as those at Lynn and the other boot and shoemaking cities were not as indispensable in a modern factory as they had been when more processes were performed by hand. Indeed, the use of less skilled labor usually involved the use of better raw materials, and western makers stressed the superior quality of their goods as compared with the cheaper products of New England, much in the same way that American silk and cotton manufacturers emphasized the durable and substantial qualities of the products of their looms as compared with the flimsy, over-sized and over-weighted fabrics of Europe.[38]

Lynn manufacturers made almost exclusively women's and children's shoes, 90 per cent of the output being classed as "ladies' goods."[39] Although it was the largest producer of shoes in the country, it did not have the largest factories. A majority of its establishments did an annual business of $25,000 to $250,000, and very few exceeded a million dollars.[40] Subsidiary manufactures naturally sprang up in the shadow of the shoe factories. Lynn was an important tanning and leather-dressing center. Independent firms made a business of supplying makers with such specialties as welts, soles, insoles, molded counters and the like. Makers of shoe tools and machines had also established themselves in the immediate vicinity of this market. In the early nineties Lynn was said to contain about 100 firms manufacturing shoe machinery and kindred supplies; 92 producing cut sole and other leather parts, and 30 engaged in tanning and leather finishing.[41]

[36] Eleventh Census, *Report on Manufactures*, Part I, 668–673; Depew, *One Hundred Years of American Commerce*, II, 569; *Boot and Shoe Recorder*, III, 137, May 9, 1883.
[37] *Boot and Shoe Recorder*, III, 107, May 2, 1883; IV, 126, Oct. 31, 1883; IV, 653, Mar. 19, 1884.
[38] *Boot and Shoe Recorder*, VIII, 1631, Mar. 24, 1886.
[39] *Boot and Shoe Recorder*, IV, 377, Jan. 2, 1884.
[40] *Boot and Shoe Recorder*, XXI, 65, Aug. 10, 1892.
[41] *E.g.*, *Boot and Shoe Recorder*, V, 351, July 2, 1884; XXI, 85, Aug. 10, 1882.

The migration of boot and shoemaking that followed the introduction of improved machinery was not from New England to the West as was feared, but from the old shoe manufacturing centers of Massachusetts to the country towns of the neighboring New England states. One motive for this change, which resembled in some respects the contemporary transfer of certain branches of silk manufacturing from Paterson to the Pennsylvania coal towns, was to secure cheaper and more docile labor. In fact small towns in Maine and New Hampshire showed the same enterprise in inducing manufacturers to set up shops and factories within their borders that the Pennsylvania towns showed in the case of silk spinning. Buildings were erected and offered rent and tax free for a period of years to firms that would transfer their operations, or a part of them, to the new site. This movement away from the old centers, particularly Lynn, was favored by the fact that the Knights of Labor had organized the shoe workers of the larger centers, who were already restless and alarmed over the changes caused by the progress of machinery, and made demands upon employers that the latter were eager to escape. Between 1882 and 1886 the number of McKay machines in use in Lynn actually declined from 171 to 137, while those employed in Maine and New Hampshire by Lynn manufacturers increased during the same period from 18 to 71. Including other sections of the country to which Lynn makers had transferred their operations, they had 103 more McKay machines working outside the city in 1886 than four years before.[42]

To be sure no permanent decline occurred in the number of shoes made at the older center. The tendency was to retain the manufacture of the better and more stylish grades at the original site, where skilled labor was available and raw materials of selected grades were easily obtained, and to transfer the production of cheaper goods to the country towns.[43] Some years earlier than this, Lynn manufacturers had tried the same experiment of shifting operatives to country establishments in order to escape onerous labor demands, but at that time machinery had not been sufficiently improved to make this profitable and the result was unsatisfactory. A compilation made in 1884 indicated that Lynn employers had almost one-third as many hands working for them outside that city as in Lynn itself. Most of their country establishments were in Maine and New Hampshire, but one was as far distant as Richmond, Virginia.[44] A disappointing feature of the situation, from the employers point of view, was that shoe workers in the smaller towns also joined the unions and occasionally cooperated with the Lynn organizations in a strike.[45]

Haverhill, which manufactured cheaper goods than Lynn, was generally regarded as a rival of the latter city. But the organization of the industry

[42] *Boot and Shoe Recorder*, VIII, 85, Oct. 14, 1885; VIII, 925, 937, Jan. 13, 1886.
[43] *Boot and Shoe Recorder*, XII, 49, Oct. 26, 1887.
[44] *Boot and Shoe Recorder*, V, 295, June 18, 1884.
[45] *Boot and Shoe Recorder*, VIII, 727, Dec. 23, 1885; VIII, 1145, Feb. 3, 1886; *Statistics of the Industries of Maine for 1886*, p. 69.

in these two neighboring towns was dissimilar. Lynn was a center of factory production. At Haverhill many cheap women's shoes and slippers were made by small manufacturers, who operated with a very modest capital in a rented room or two which they used for office purposes and for cutting out their leather. The rest of the work was done by outside contractors. This system prevailed until 1890 or later. It was not until the latter year that a tendency to bring the business in from the suburban outworkers, many of whom were farmers, to central factories began to attract attention. By the end of the century, however, this quasi-household system, which had once prevailed throughout New England and still survived even in Lynn on a small scale, was rapidly disappearing.[46]

Brockton, which ranked next to Lynn as a shoe manufacturing center and was to reach the first position during the following decade, made principally men's wear. Partly for this reason, since the making of men's shoes with their heavier materials could not be contracted out to the same extent as the manufacture of lighter goods, Brockton's factories were much larger than those of Lynn and Haverhill. A contemporary review of the industry in that city, written in 1885, mentioned as the three most important developments of the five years preceding, the widespread organization of labor unions, the introduction of improved machinery supplanting hand operations, and "the new competition of cheap shoes with the highest grades brought about by enterprising imitation and ingenious advertising." Between 1880 and 1890 the annual shipments of shoes from Brockton increased in round numbers from 190,000 to 470,000 cases.[47]

New York City was a shoemaking center of some importance, one firm manufacturing to the extent of about a million dollars annually. This city, like Rochester in the same state, which surpassed the metropolis in this industry, specialized in fine goods. While Lynn turned out ladies shoes for as low as 75 cents a pair, the minimum grade produced in Rochester sold at the factory for $2. The daily output of the latter city in the middle eighties was not far from 10,000 pairs, almost entirely ladies' and children's goods.[48] Philadelphia led the country in the production of children's and infant's shoes. The manufacturers of this city also, like those of Rochester, prided themselves on the superior quality of their work. In 1890 Philadelphia reported 93 establishments engaged in this industry, while Rochester with almost an equal product had but 51. This was characteristic of Pennsylvania's artisan metropolis. Only three years earlier than this an account of the industry in the former city recorded as an interesting fact than many shops that had hitherto worked only hand machines were introducing steam power.[49]

[46] *Boot and Shoe Recorder*, XVII, 79, May 21, 1890; XVII, 81, May 28, 1890; Twelfth Census, *Reports*, IX, 741.

[47] *Boot and Shoe Recorder*, VIII, 87, Oct. 14, 1885; VIII, 317, Nov. 11, 1885; XXII, 83, Dec. 7, 1892.

[48] *Boot and Shoe Recorder*, V, 399, July 16, 1884; XII, 29, 75–76, Oct. 5, 1887.

[49] *Boot and Shoe Recorder*, IX, 351, May 12, 1886; XII, 55, Oct. 9, 1887; XVII, 75–76, Jan. 1, 1890; Eleventh Census, *Report on Manufactures*, Part II, 438–411, 490–493.

Cincinnati, like Chicago, St. Louis and Milwaukee, manufactured heavier goods mostly for men's wear. In 1890 this business was prosperous in the Ohio metropolis although the facts that wages were higher and raw materials were more expensive than in the East prevented expansion into cheaper lines. As early as 1883 St. Louis, which was just coming on to the stage as a shoe-producing center, had 6 establishments manufacturing men's shoes and 13 establishments producing women's and children's shoes. While this manufacture was extending in the West, it made little advance in the South, although occasional notices of new establishments in that section appeared in the trade press.[50]

BOOT AND SHOE TRADE

Tendencies toward finer and higher quality output, already visible in the industry before 1873, manifested themselves more strongly as years passed by. Manufacturers turned out goods in a great variety of lasts and in what could have been considered previously a minute gradation of sizes, both as to length and to width. Shoes were standardized—that is, a letter and number meant the same thing in whatever factory or town ofthe United States a shoe was made. The old torture of "breaking in" new footgear was reduced to a minimum. The appearance and style of American shoes continued to improve until it was no idle boast that the Americans were the "best shod nation in the world." The larger use of light upper leathers of high quality, that followed the invention of improved tanning processes, contributed to this development. While this superiority probably existed at a somewhat earlier date, it was not generally recognized abroad until the World's Fair of 1893 at Chicago, at the close of the period we are now describing.[51]

At this time our exports of footwear were still modest. They had reached their maximum during the earlier history of the country in the midst of the Civil War, when we shipped abroad well toward 1,250,000 pairs, worth, however, but a little more than that number of dollars. At no subsequent date did our foreign shipments rise materially above half of this amount until 1892, when we sent nearly 750,000,000 pairs to foreign markets. During this period, however, the total value of our exports of leather and leather manufactures was rapidly growing, rising from $3,194,000 in 1865 to about $12,000,000 thirty years later. We shipped leather rather than boots and shoes to other countries, however, partly because American shoemaking machinery had been introduced abroad and the American method of manufacture had been adopted by foreign competitors of our own factory owners. In 1892 when the value of the boots and shoes ex-

[50] *Boot and Shoe Recorder*, III, 101, May 2, 1883; III, 125, May 9, 1883; III, 547, Sept. 5, 1883; XVII, 75, Jan. 8, 1890; XVIII, 77–78, June 25, 1890.

[51] Depew, *One Hundred Years of American Commerce*, II, 572–573; *Boot and Shoe Recorder*, IV, 238, Nov. 28, 1883; XXI, 109–110, July 13, 1892; Twelfth Census, *Reports*, IX, 757–758.

ported from the United States was less than $1,000,000, the value of those shipped from England reached nearly $8,500,000.[52]

The tardiness with which American manufacturers entered the foreign market was probably due more largely to commercial obstacles than to high costs of production, at least during the latter years of this period. A computation made in 1876 indicated that English makers could turn out shoes of equal quality with those made in America at considerably lower costs than then prevailed in New England.[53] Nevertheless even at that time small quantities of American "machine-made boots and shoes" were reaching the Birmingham district.[54] In 1883 raw materials with the exception of a few unimportant items such as lastings, linings and other findings, were as cheap or cheaper in America than abroad, and improved machinery had reduced labor costs to an equality with those in Europe. But our manufacturers did not take the trouble "to turn out the peculiar styles of goods wanted in foreign markets." Furthermore customs obstacles and the lack of direct and regular steamship communication with promising markets, such as those of Latin America, placed American shippers at a disadvantage compared with their British and Continental competitors.[55] By 1892, however, these conditions were changing in our favor. English samples and lasts were to be found in Brockton factories to guide manufacturers in making goods for the British trade, and shipments to South and Central America were growing.[56]

STYLES AND FASHIONS

The old-fashioned top boots, which began to lose their popularity soon after the Civil War, were becoming so rare by 1880 that their disappearance was cited as one cause of the dullness in the leather market.[57] Heavy brogans, which had also been a standard product of the shoe trade a generation before, had likewise become a thing of the past. Brockton had got its start in the shoe industry by manufacturing brogans, and the change from them to the gracefully shaped men's shoes of the eighties with their French calf-skin, vici kid or kangaroo tops, typified the revolution in American footwear within three decades. Tan shoes in all their various shades came into fashion at this time, first for summer wear and later, somewhat hesitantly, for winter service. Tan brogans had been made before the Civil War for negro consumption in the South, where shoe blacking

[52] Depew, *One Hundred Years of American Commerce*, II, 573–574; U. S. Industrial Commission, *Reports*, XIV, 499; U. S. Tariff Commission, 1882, *Report*, I, 585, 903, 904, 1036; *Boot and Shoe Recorder*, VIII, 273, Nov. 4, 1885; XXI, 51, Apr. 6, 1892; National Association of Wool Manufacturers, *Bulletin*, X, 147, Apr. 1880.

[53] National Association of Wool Manufacturers, *Bulletin*, VI, 280–281, Oct. 1876.

[54] American Iron and Steel Association, *Bulletin*, XI, 165, June 13 and 20, 1877; *cf.*, *ibid.*, XI, 98, Apr. 11, 1877.

[55] *Boot and Shoe Recorder*, III, 617, Sept. 26, 1883; IV, 266, Dec. 5, 1883; IV, 350–351, Dec. 26, 1883.

[56] *Boot and Shoe Recorder*, XXII, 99, Nov. 23, 1892.

[57] *Boot and Shoe Recorder*, V, 718, Sept. 17, 1884.

was a luxury in the slave cabins and masters had an idea that the uncolored leather was the more durable. But the idea that men's shoes could be any other color than black was a novel one fifty years ago.[58]

At the time when top boots and brogans were worn for rough outdoor service over the greater part of the United States, cloth was almost the only material though fit for shoe uppers for ladies' wear. The same fashion made cloth shoes for men the proper thing for indoor and city use. The most popular materials for uppers were serge and lasting, which were often colored, especially for ladies goods, and American imports of these materials were heavy. Cloth-topped shoes, varied for winter wear with felt and beaver instead of lasting, were commonly worn in some parts of the country up to the late eighties.[59] About 1875 felt boots, which were first made in Canada, a little later in Michigan, and in 1878 on a larger scale in Boston, became a staple article in the trade. They were worn with rubber overshoes and were especially popular with lumbermen. The latter fact probably explains why two of the largest factories making them were in Michigan. Canvas shoes, which seem to have been recommended to popular favor by baseball players, also appeared in the market about that time.[60]

MARKETING METHODS AND ORGANIZATION

During the early eighties manufacturers began to advertise directly to consumers standard priced shoes under a trade-mark brand. James Means and Company claimed to be the originators of this idea. The price of their $3 shoe was stamped on the sole, and it was first advertised in January 1883. The W. L. Douglas $3 shoe entered the market almost simultaneously. This was the beginning of direct contact between the manufacturer and consumer and logically led to the distribution of shoes through retail stores owned by the makers. Some who did not adopt this device dropped the jobbing trade and sold principally or exclusively to retailers. The higher price the manufacturer thus obtained for his goods more than paid his extra merchandising costs.[61] The influence of these new practices was to standardize and guarantee the quality of the shoes thus offered to the public. It enabled the manufacturer to make an asset of popular good will. This change in selling methods was also encouraged by certain evils that had crept into the dealings of manufacturers with jobbers, especially the practice of dating bills ahead, or privately extending the period of credit granted the jobber as an inducement to get his trade. The same evil existed in the woolen business and had begun "to eat large holes" in manufacturers' profits.[62] Selling boots and shoes at auction also became

[58] *E.g.*, *Boot and Shoe Recorder*, XXII, 45, Oct. 19, 1892.

[59] *Boot and Shoe Recorder*, XI, 83, Apr. 6, 1887.

[60] *Boot and Shoe Recorder*, V, 433, July 23, 1884; V, 484, July 30, 1884.

[61] *Boot and Shoe Recorder*, III, 300, June 27, 1883; IV, 368, Dec. 26, 1883; IV, 552, Feb. 20, 1884; V, 43, Apr. 9, 1884; XVII, 59, Apr. 23, 1890; Depew, *One Hundred Years of American Commerce*, II, 572.

[62] *Boot and Shoe Recorder*, III, 325, July 4, 1883; IV, 297, Dec. 12, 1883.

an important feature of the business. At first it was a device to dispose of inferior or damaged goods, but it eventually developed into a recognized method of realizing cash on a manufacturer's stock in hand. As a rule auctions attracted buyers from the remoter or more rustic sections of the country, where customers were not particular in the matter of the latest styles.

No attempt was made to organize large combinations in the boot and shoe industry. The dispersion of manufacturing in numerous moderate sized establishments, the system of renting machinery from its makers and the wide variations in the quality and style of output of different factories and localities, combined to discourage such a measure. But local and national organizations of shoe manufacturers existed with the object of defending their common trade interests. In 1883 the national body proposed to form a separate corporation to manufacture shoe nails for which makers demanded what were considered exorbitant prices. The same organization dealt in behalf of all its members with makers of shoe machinery, thus bringing concerted pressure to bear upon the latter in the matter of rental contracts. The New England Shoe and Leather Association, among other services to its members, maintained a credit bureau. A few cooperative shoe factories were started in New England during the eighties. At one time there were no less than four of these at Stoneham, Massachusetts, one of which had a long record of successful operation.[63]

HARNESS AND SADDLERY

Like shoemaking, the manufacture of saddlery and harness profited largely during these two decades by new inventions. The lock-stitch sewing machine using waxed thread was patented and perfected during the seventies, and to a great extent supplanted hand sewing, which survived in this branch of leather manufacturing longer than it did in shoemaking. This stitch made the seam look alike on both sides, and removed an objection to sewing machines for harness making as long as the chain stitch was used, which had hitherto prevented their general introduction. The new machines, like boot and shoe-making machinery, were leased to manufacturers for a fixed charge, plus a rental of five cents for each 1,000 stitches. This was changed to a monthly rental as patents approached their expiration and competition among machine makers sprang up. In addition to this improvement, tubular riveting machines, quilting machines, a machine for stuffing horse collars, and a metal staple machine for sewing staples on collars, were invented during this period. The center of saddle and harness making was in the West. In 1890 Cincinnati and St. Louis were the largest producers in America. Farther west and south other cities, like Dallas, Texas, began to acquire more than local importance in this industry. Their

[63] *Boot and Shoe Recorder*, IV, 70, Oct. 17, 1883; IV, 447, Jan. 23, 1884; IV, 481, Aug. 20, 1884; XII, 38, Nov. 2, 1887.

factories supplied not only the ranching and mining market still farther west, but also built up an export trade with Mexico.[64]

RUBBER MANUFACTURE

No revolutionary changes occurred during these two decades in the processes of rubber manufacturing or in the application of rubber to new uses. Nevertheless the expansion of the industry was very marked. In 1875 the consumption of raw rubber in the United States was under 10,000,000 pounds per annum. By 1893 it had reached the neighborhood of 33,000,000 pounds. This was in addition to the rubber reclaimed.[65] Probably the total weight of rubber manufactured in the United States, including reclaimed rubber, had quadrupled.

In the Centennial year, when 12,000,000 pounds of raw rubber were imported, mostly from Brazil, over seventy firms were making rubber products and the value of their annual output was estimated to exceed $26,000,000. The chief use of rubber at this time, as it continued to be until the multiplication of automobiles, was for making footwear. Solid rubber tires, which had been used experimentally many years before, came into general use during the eighties with the improvement of the bicycle. But this new employment, which by the close of the period we are describing accounted for the consumption of some 6,000,000 pounds of raw rubber annually, was still secondary to the manufacture of hose and belting, as well as to that of boots and shoes.[66]

America had always taken the lead in the manufacture of waterproof footwear, an industry that preceded the revolutionary discoveries of Goodyear, although it was not entirely successful until those discoveries were applied to manufacturing. The value of rubber boots and shoes made in this country doubled during the ten years ending with 1890, when it reached $18,632,000; and the output of the United States at the end of this period was approximately 40,000,000 pairs a year, or some six times the number made in Great Britain and Europe. This precedence was due not only to the start given the industry in the Americas by the Goodyear patents, but also to the greater use of labor-saving machinery and to the larger market for rubber footwear which the consumers of the United States afforded.[67]

England preceded America in the manufacture of waterproof clothing. It was the demand created by the Civil War for rubber coats and blankets that firmly established their manufacture on this side of the Atlantic; but these earlier goods were chiefly of a heavy sort worn almost exclusively by men. In the seventies a light gossamer rubber garment for women was

[64] Depew, *One Hundred Years of American Commerce*, II, 577–578.

[65] Depew, *One Hundred Years of American Commerce*, II, 503.

[66] U. S. Centennial Commission, *Reports and Awards*, V, Group X, 10, 17; National Association of Wool Manufacturers, *Bulletin*, VI, 134–136, Apr. 1876; Depew, *One Hundred Years of American Commerce*, II, 501.

[67] Twelfth Census, *Reports*, IX, 771; Depew, *One Hundred Years of American Commerce*, II, 502–503.

introduced, but its popularity soon waned on account of the inferior quality of its materials. During the eighties the manufacture of mackintoshes was successfully transplanted from Great Britain to America.[68]

Massachusetts led the other states by a wide margin in the value of its rubber manufactures and with Connecticut and Rhode Island produced nearly nine-tenths of the rubber footwear made in the country. During the late eighties the trade in rubber boots and shoes was in a somewhat unsatisfactory condition, due partly, it was said, to the practice of shoe jobbers and retailers of selling these goods below cost as leaders. Several New England manufacturers combined their sales organizations under the name of the Rubber Boot and Shoe Selling Company in order to standardize prices and trade practices. But some large companies remained outside of the agreement and the enterprise did not endure. As in the leather shoe trade, annual auctions were held to clear manufacturers' stocks.[69]

Conditions were therefore favorable for the movement toward consolidation, which became so marked in the industrial world about 1890, to manifest itself in this group of manufactures. It resulted in the eventual formation of two large companies, in different fields of production, the United States Rubber Company, incorporated in 1892 with an authorized capitalization of $50,000,000, which purchased or bought into nearly all the rubber footwear interests in the country, and the Mechanical Rubber Company, incorporated the same year, with a capital of $15,000,000, which controlled factories, mainly in the West, engaged in the manufacture of rubber hose and belting and other goods of a similar character. The latter Company eventually passed into the hands of a larger organization, the Rubber Goods Manufacturing Company, which made all classes of rubber goods except boots and shoes.[70] The United States Rubber Company owned at the time of its organization 9 factories of the 15 then engaged in making rubber footwear. Of these, 3 were in New Jersey, 5 in New England, and 1 in Louisiana. The Mechanical Rubber Company embraced 15 factories, including the New York Belting and Packing Company, the Chicago Rubber Company and the Cleveland Rubber Company. At this time, two of the largest manufacturers of rubber boots and shoes, the Boston Rubber Shoe Company at Malden and the Woonsocket Rubber Company, remained outside of the former combination, although they had "an offensive and defensive alliance" with it.

Plantation rubber was still practically unknown, and the greater part of the world's supply, of which more than half was consumed in the United States, came from the forests of the Amazon Valley. Consequently the production of raw rubber, and the trade in this commodity, remained out-

[68] Depew, *One Hundred Years of American Commerce*, II, 502.

[69] *Boot and Shoe Recorder*, IX, 101, Apr. 14, 1886; XI, 39, June 8, 1887; XII, 39, Nov. 2, 1887; XII, 35, Nov. 16, 1887; XII, 31, Dec. 7, 1887.

[70] *Boot and Shoe Recorder*, XX, 55, Mar. 9, 1892; XXI, 121, Apr. 6, 1892; *Commercial and Financial Chronicle*, LV, 374, Sept. 3, 1892; LV, 680, Oct. 22, 1892; LV, 1039, Dec. 17, 1892; LVI, 539, Apr. 1, 1893; LVI, 792, May 13, 1893; U. S. Industrial Commission, *Reports*, XIII, 34.

side the control, or the direct interest, of the great companies who were engrossing a major share of its manufacture in America. At times factories found themselves face to face with only a three-weeks' supply of materials in the country.[71] This resulted in radical fluctuations in rubber prices, which it was one object of these large combinations to control.[72]

[71] *The India Rubber World,* II, 252, Aug. 15, 1890.
[72] *E. g., The India Rubber World,* June 15, 1890.

CHAPTER XLI

MANUFACTURES OF WOOD

LUMBER INDUSTRY

Between the Civil War and 1890 the principal center of the lumber industry was the Great Lakes region; and Michigan and Wisconsin accounted for nearly 30 per cent of the country's output. During the ten years ending with 1884 the quantity of white pine sawed annually in this district approximately doubled, increasing in round numbers from 4,000,000,000 to 8,000,000,000 feet. The Saginaw Valley reached its maximum output, of over 1,000,000,000 feet, in 1882, and the Menominee River district made its largest cut, of about two-thirds that amount, six years later.[1] The industry was also growing rapidly on the Pacific coast, which in 1881 produced about 650,000,000 feet per annum. This expansion, especially around Puget Sound, was due largely to export and coastal markets served by water transportation and the mills, which bought their logs from loggers, were usually erected close to tidewater.[2] Between 1880 and 1890 many new mills were built throughout the South and in the course of the following decade the value of the saw-mill products of that section rose from $40,000,000 to $188,000,000.[3] Cypress lumber began to come into the general market. Logging operations to procure this timber often involved the construction of canals and other expensive means of access to the cypress swamps, a condition that caused this industry to fall into the hands of strong companies operating with a large capital. By 1891 the southern cottonwood, which was not a suitable timber for ordinary structural use, began to be employed for boxing. The production of cooperage stock also increased rapidly in the South.

In that section, as in the Pacific northwest, much lumber was made for distant markets and the industry was highly capitalized. Consequently large establishments were the rule. But even in the older and still thriving saw-mill districts of the East the same tendency toward concentration was visible. Between 1880 and 1890 the average capital per mill more than trebled and the output more than doubled. While the total value of product rose from $210,000,000, or $168,000,000 on a gold basis, in 1870 to

[1] *Northwestern Lumberman*, quoted in American Iron and Steel Association, *Bulletin*, XIX, 93, Apr. 8, 1885; *Curiosity Shop*, 329.

[2] Hittell, *Commerce and Industries of the Pacific Coast*, 582–583; American Iron and Steel Association, *Bulletin*, XXIV, 243, Aug. 27, 1890.

[3] Bruce, *Rise of the New South*, 90.

$404,000,000 in 1890, the number of mills decreased during that period from 25,832 to 21,011.[4]

A remarkable, but typical feature of the history of the lumber industry during this period was the increasing share of the selling price of the product represented by the cost of raw materials. According to the reports of the Board of Trade of Saginaw, at this time one of the principal primary lumber markets of the Union, stumpage values in Michigan increased sixfold between 1866 and 1886, while the price of rough pine boards remained practically stationary. The narrower margin of manufacturing was due chiefly to improvements in machinery and economies of organization. One of the simplest yet most valuable aids of the logger, the peavy or cant-hook, was not perfected until after 1870. The use of saws for felling trees, and the substitution of the band saw for the circular saw, at least to square logs for the gangs, also date from this period.[5] As early as the seventies gangs of fifty-four saws were in use.[6]

Until 1872, when the first specific duty was levied on lumber, amounting to two dollars a thousand feet on pine and one dollar on hemlock and other cheaper woods, the tariff played little part in the history of this industry. Logs were on the free list, and the previous ad valorem duty of 20 per cent had little influence except at a few points near the Canadian border. But during the following ten or fifteen years the American mills along the Great Lakes, having cut much of the merchantable timber in their section of Michigan and Wisconsin, began to raft over logs from the still intact timber limits on the Canadian shore. Several of the great Saginaw mills, for instance, became largely dependent on this source of supply, and Michigan lumbermen bought extensive stumpage rights in Ontario. Meanwhile Canadian saw mills were expanding and became increasingly dependent on export markets for their prosperity. They shipped high-grade timber products, as a rule, to Great Britain and coarser products to the United States. In 1881 Canada, in retaliation for the American lumber duty, levied an export tax of one dollar a thousand feet on logs, and doubled this tax five years later, after the American duty on lumber had been still further increased by the Act of 1883. To be sure, the log trade between the two countries was reciprocal, and some Canadian mills cut logs from the south side of the border; but the Canadian tax nevertheless bore more heavily upon American mill owners—especially those who had large investments in Ontario stumpage, than a retaliatory export tax would have borne on their northern competitors.[7]

As a consequence of this situation an understanding was reached by which American duties on lumber were reduced in the Tariff Act of 1890 to half

[4] Eleventh Census, *Report on Manufactures, Selected Industries*, 595; Depew, *One Hundred Years of American Commerce*, I, 198; U. S. Tariff Commission, 1882, *Report*, I, 1018, 1019, 1023, 1025

[5] Depew, *One Hundred Years of American Commerce*, I, 201–202.

[6] Bolles, *Industrial History of the United States*, 506.

[7] U. S. Committee on Ways and Means, *Hearings*, 51st Cong., 1st sess., 783.

their former amount, and Canada abolished her export tax. At once American imports of logs from Canada began to rise, from 80,000,000 feet in 1891 to 298,000,000 feet two years later. This situation lasted until the Wilson bill, of 1894, placed lumber on the free list.[8]

Planing-mill products, including sash, doors and blinds, had long since supplanted the products of the joiner's handicraft and their manufacture was already sufficiently centralized to serve comparatively large market areas. This was indicated by the facts that machine-made doors, window frames and sashes were a considerable article of export, and that in 1888 manufacturers of these articles in New England, New York and Pennsylvania organized a pool to control prices. Similar local agreements existed among producers in certain cities.[9]

FURNITURE MAKING

By the late seventies eastern furniture was ceasing to compete with Michigan furniture in the Chicago market and at points farther west. A leading hotel at Dundee, Scotland, was reported in 1879 to be furnished throughout with the products of Grand Rapids factories.[10] During the eighties and subsequently, furniture-making extended notably in the South, especially in the hardwood regions of the Appalachian highlands. The Centennial Exposition, where the American exhibits were chiefly remarkable for "superiority of machine-work,"[10] stimulated an interest in the art aspects of this industry, as in many others, that after much errant effort eventually resulted in better designs than had previousy been the vogue. This new influence was possibly strongest, or at least had the most visible effect, in the West and helps to explain the success of local makers in ousting their eastern competitors from the western market. The Centennial inaugurated an Eastlake period, followed some ten years later by a Romanesque fashion accompanying the Richardson era in American architecture. Romanesque furniture lost popularity as soon as its designs were applied to cheaper articles, and was followed by an Empire vogue introduced by the displays of French furniture at the Paris Exposition of 1889.[11]

Notwithstanding the advantages that western furniture makers enjoyed in their proximity to hardwood forests and to a rapidly growing local market, New York still led the states in value of product, followed by Illinois and Michigan in the order named. But until well after 1890 Massachusetts made more chairs than any other state, retaining a rank in that branch of the industry which it had held since the days when Yankee colonial skippers peddled the products of New England cabinet shops to the planters of the southern colonies and the West Indies.[12]

[8] Defebaugh, *History of the Lumber Industry in America*, I, 445–449.
[9] American Iron and Steel Association, *Bulletin*, XIII, 177, July 16, 1879; XXII, 117, Apr. 11, 1888; U. S. Industrial Commission, *Reports*, VIII, 164.
[10] American Iron and Steel Association, *Bulletin*, XIII, 314, Dec. 10, 1879.
[11] Depew, *One Hundred Years of American Commerce*, II, 630–631; U. S. Centennial Commission, *Reports and Awards*, IV, Group VII, 2.
[12] Eleventh Census, *Report on Manufactures*, I, 203.

VEHICLES

Even as recently as 1893 vehicles were made principally of wood. The change from animal to mechanical traction was likewise a change from wood to steel; but up to the date mentioned horse-drawn vehicles were in almost universal use. The carriage builders of the United States organized in 1872 a national association, which gathered statistics of the trade and among other things established a school in New York to teach the science of carriage drafting and construction.[13] In the early eighties several factories in the West had facilities for making from 5,000 to 15,000 buggies a year; and in 1887 it was estimated that the members of the Carriage Builders' National Association were turning out annually about 1,250,000 carriages.[14]

During the early nineties the trade was much depressed, and it is interesting to note that one explanation suggested for the decline in demand was the rapid increase of bicycles, of which some 500,000 were made and sold in the United States annually. Ohio and New York led in statistics of vehicles produced, their output being valued at double that of Illinois and Indiana, which stood next in rank. Connecticut, which at one time was a leading carriage-making state, had already lost its early prominence in that industry, although Massachusetts continued to hold sixth place, following immediately after Pennsylvania in this line of manufacture.[15]

WOOD PULP

When the manufacture of both mechanical and chemical wood pulp began in the United States during the middle sixties, the initial step was taken toward ranking paper-making among the forest industries. To be sure, the new material was not generally adopted at once, and even today other fibers continue to be employed in this manufacture; but during the period we are describing the center of gravity of the industry shifted to mills using wood pulp, and its geographical distribution began to be affected by the presence of timber supples.

For a time prejudice and vested interests combated the new material Newspaper publishers, whose business was to owe its vast expansion in no small part to this invention, opposed the use of wood-pulp paper and even specified in their contracts that not more than a certain percentage of pulp should be used in the paper they purchased.[16] With the introduction of sulphite pulp, which was first made in America at Providence, Rhode Island, in 1884, nearly twenty years after the earliest soda pulp was made in Pennsylvania, it became possible to produce a better all-wood-stock paper than

[13] Depew, *One Hundred Years of American Commerce*, II, 520.

[14] American Iron and Steel Association, *Bulletin*, XVII, 137, May 23, 1883; XXI, 299, Oct. 26, 1887.

[15] American Iron and Steel Association, *Bulletin*, XXIX, 237, Oct. 20, 1895; Eleventh Census, *Report on Manufactures*, I, 151, 153.

[16] U. S. Tariff Commission, 1882, *Report*, I 985; Weeks, *A History of Paper Manufacturing in the United States*, 228.

hitherto. Patent rights also delayed the general adoption of the new material, the royalty on wood pulp being for many years $10 a ton.[17]

As long as American paper-makers used rags as their raw material they drew a considerable share of their supplies from the linen-using countries of Europe and the Levant. Therefore they had no advantage in this item of cost over their European competitors; and mills in countries levying an export duty on rags might procure them cheaper than our own establishments. But the change to wood fiber placed our manufacturers in a preferred position so far as pulp produced mechanically was concerned; although on account of the cheapness of chemicals in Europe soda and sulphite pulp cost no more, or even less, there than in America.[18]

The first chemical pulp manufactured in the United States was made from poplar. Spruce and pine were also employed. American pulp was rated somewhat inferior to the best spruce pulp from northern Europe, but some American makers ascribed this preference to prejudice alone. Canada, with her vast forest wealth, soon became a competitor in the American market. Domestic pulp manufacturers considered that their rivals north of the boundary had an undue advantage on account of their freedom from patent royalties in addition to their cheaper labor, timber and water-power. In a word, the Dominion and the Union stood in much the same relation to each other in respect to pulp making that they did in respect to the lumber industry.[19]

Wood pulp made paper cheaper and more abundant, but not better in quality. Indeed rag paper continues even today to be the more durable and attractive of the two. But the reduction of price had far-reaching consequences, not only in the publishing business but in other employments where lowering costs multiplied its uses. Book papers which were quoted at 12½ cents a pound during the low-price era before the Civil War, and rose to double or more that figure subsequently, fell to 7½ cents a pound during the eighties. Print paper, which was 24½ cents a pound at the close of the war, was less than 3 cents a pound in the early nineties.[20] Pulp mills multiplied rapidly. In fact, there was a boom in this industry in the early eighties which resulted in overproduction and an agreement among paper makers to control prices so as to maintain the industry on a profit-paying basis.[21]

In 1882 the daily capacity of the pulp mills of the United States was estimated at 300 tons. By the close of the decade American paper mills

[17] Eighth International Congress of Applied Chemistry, *Original Communications*, XIII, 77; Weeks, *History of Paper Manufacturing in the United States*, 230–232; U. S. Tariff Commission, 1882, *Report*, I, 852.

[18] U. S. Tariff Commission, 1882, *Report*, I, 232–233, 977; U. S. Committee on Ways and Means, *Hearings*, 51st Cong., 1st sess., 719, 724; U. S. Committee on Ways and Means, *Tariff Hearings*, 53d Cong., 1st sess., 1052; Chapman, *Foreign Competition*, 237.

[19] U. S. Tariff Commission, 1882, *Report*, I, 986–987, 990; U. S. Committee on Ways and Means, *Hearings*, 51st Cong., 1st sess., 719.

[20] U. S. Tariff Commission, 1882, *Report*, I, 596; Weeks, *A History of Paper Manufacturing in the United States*, 236, 287, 297.

[21] U. S. Tariff Commission, 1882, *Report*, I, 1147.

consumed annually some 225,000 tons of mechanical pulp and 124,000 tons of chemical pulp, of which 53,000 tons was the high-grade sulphite fiber.[22] Even in 1890 our mills used more rags and waste paper by 26,000 tons per annum than they did wood pulp of all kinds. Their consumption of straw stock was 355,000 tons, and of manila stock, including rope waste and the like, 525,000 tons. The latter material, was used only for straw board, paste board, wrapping paper and similar products.[23] Three years later more than one millon tons of wood pulp were consumed in the United States, roughly in the proportion of three tons of mechanical fiber to two tons of chemical fiber. Of this quantity 64,000 tons in round numbers, consisting mostly of high-grade sulphite pulp, were imported. Prices had fallen by this time to $1\frac{1}{4}$ cents a pound for mechanical pulp and $2\frac{1}{4}$ cents for chemical pulp, a reduction reflected in the low price of paper just mentioned.[24]

PAPER

Naturally, during a process of rapid expansion such as was now occurring, many improvements and minor inventions were made in the equipment of paper mills, but there was no revolutionary change in methods of manufacture to affect the organization of the industry or the processes it employed. The uses to which paper was put multiplied and the variety of paper and paper-like products increased to correspond. About 1876 the paper-collar industry reached its height. The Fall River bleachery was equipped to make daily from 15,000 to 20,000 yards of paper-collar stock consisting of paper on a cheap cloth base. As this material was a yard wide, the number of collars stamped from the goods produced by this one establishment can easily be imagined.[25]

Shortly before the period we are describing, paper car wheels were manufactured successfully, and with the lighter rolling stock then in use they were employed advantageously even under locomotives. These wheels consisted of paper and paste compacted under hydraulic pressure into a solid mass resembling ebony and subsequently bored out and reamed to take a steel hub and tire. They were more elastic than iron and reduced vibration, an advantage that led to their early use under sleeping cars. The Allen Paper Carwheel Company, with large shops at Hudson, New York, and Pullman, Illinois, sold 13,000 of these wheels in a single year. Some of the larger of them were 120 inches in diameter. Such wheels cost much more than iron wheels, but they wore eight or ten times as long, made less noise, reduced jarring and consequently wear on cars, and were less likely than iron wheels to fracture.[26]

[22] U. S. Tariff Commission, 1882, *Report*, I, 986.
[23] Eleventh Census, *Report on Manufactures*, 724–725.
[24] U. S. Committee on Ways and Means, *Tariff Hearings*, 53d Cong., 1st sess., 1047–1048.
[25] Peck and Earl, *Fall River and Its Industries*, 150.
[26] American Iron and Steel Association, *Bulletin*, XIII, 257, Oct. 15, 1879; XIV, 145, June 16, 1880; XVIII, 9, Jan. 9, 1884; XXI, 187, July 13, 1887.

Among the novelties exhibited at the Paris Exhibition of 1878 was a newly-invented paper barrel, manufactured in the United States. These barrels had vertical sides, took up less room in transport and warehousing, and were reported to be stronger and more durable than wooden barrels.

American paper mills had no mechanical advantages over those of their European competitors, yet on account of specialization of product and the speeding-up of machinery their output per employe was estimated to be more than double that abroad.[27] Paper and paper pulp were both protected by high duties, but home competition prevented prices from becoming exorbitant. Indeed, they were sometimes lower in the United States than in Great Britain. American makers exported paper to England in the seventies and the foreign trade in this commodity grew during the following decade.[28]

Paper making has always been a widely distributed industry, despite the development of well-defined centers where the number and size of mills and the value of output are larger than in all the remainder of the Union. In 1872 thirty-three states shared the 812 paper mills in the country, but so unequally that while each of five of these states reported but a single establishment, New York had 190 and Massachusetts had 134. Notwithstanding its fewer establishments, however, the latter state made nearly twice as much paper, measured in value, as New York, and practically one-fourth of the country's output.[29]

In 1890 the number of paper mills proper had fallen to 567, situated in thirty states, of which ten reported only one or two establishments. Massachusetts still stood second to New York in number of mills, but she again far outranked her neighbor in capital invested and value of product. But while the number of individual plants had decreased during the preceding eighteen years, their aggregate capital and output had grown rapidly. Including pulp mills and plants making certain paper specialties, like paper hangings and cardboard, which enterprises brought the total up to 696, the value of product was now more than $88,000,000; and Massachusetts alone accounted for a full quarter of this amount.[30]

Testimony varies as to the number of pulp mills in the United States at this time. The census reported 82, but a detailed list presented in evidence given before the Ways and Means Committee that year contains the names and locations of 181 mills, of which 13 used the sulphite process.[31] There had been 8 establishments altogether in 1870. One result of the substitution of wood stock for rag stock in paper making was to encourage the growth of the industry in timber-producing states like Michigan and

[27] Chapman, *Foreign Competition*, 237.

[28] American Iron and Steel Association, *Bulletin*, XI, 131, May 16, 1877; Weeks, *History of Paper Manufacturing in the United States*, 291.

[29] National Association of Wool Manufacturers, *Bulletin*, VI, 79, Apr. 1876.

[30] Eleventh Census, *Report on Manufactures*, 62, 722–726.

[31] Committee on Ways and Means, *Hearings*, 51st Cong., 1st sess., 720–721; Twelfth Census *Reports*, IX, 1025.

Wisconsin. The latter had 19 mills in 1890 with an aggregate annual output valued at over $4,000,000.

Notwithstanding the dispersion of the industry, there were paper making towns just as there were glass and pottery making, and silk and cotton spinning towns. Holyoke, Massachusetts, claimed to be the greatest fine paper manufacturing center in the world. It had 22 mills making daily 180 tons, or more than half of the fine writing paper produced in the country.[32] In contrast with this, on the Pacific coast, which had 7 mills in 1881 and 5 mills in 1890, no writing paper whatever was made, the product being limited to wrapping and newsprint paper and strawboard.[33] Even before 1880 the United States was said to make more than one-third of all the paper produced in the world.[34] Although such figures must be taken with some qualification, the industry was, relatively to that of older manufacturing countries, a very large one, and its technique, organization and products were accomodated to a large, standardized market such as the United States afforded. The printer's demands upon it were the most extensive, calling for 325,000 tons of book and newsprint paper per annum. Wrapping papers of all varieties, from Manila through "bogus Manila" to straw, accounted for nearly 260,000 tons more of the total product. Building and roofing paper, an article unknown until the introduction of cheap wood and straw fibers, added an item of nearly 50,000 tons. Altogether 32 distinct kinds of paper and pasteboard were thought important enough to be recorded separately in the eleventh census. Included among these were three varieties of tissue paper, of which between 6,000 and 7,000 tons were made annually.[35]

For a time the manufacture of certain classes of thin paper in America was practically suspended on account of heavy importations, although well-equipped mills existed for their production. After the imposition of a heavier tariff in the McKinley Act, American mills resumed the manufacture of these papers, and in 1893 they were supplying about half of the domestic market. Until as recently as 1890, members of Congress, while thus protecting American makers, imported English paper for their official stationery, to the intense disgust of Massachusetts mill owners, who claimed to manufacture paper of equal quality.[36]

Although paper was still made by hand until after 1893 in at least one establishment, the old process had been largely displaced by mechanical methods of manufacture long before 1873.[37] The technical progress of the

[32] *Boston Journal of Commerce*, Oct. 17, 1885; *cf.* Eleventh Census, *Report on Manufactures, Statistics of Cities*, 246–248; Weeks, *History of Paper Manufacturing in the United States*, 284.

[33] Hittell, *Commerce and Industries of the Pacific Coast*, 635; Eleventh Census, *Report on Manufactures*, 726–727.

[34] American Iron and Steel Association, *Bulletin*, XIII, 331, Dec. 24 and 31, 1879.

[35] Eleventh Census, *Report on Manufactures*, 726–729.

[36] U. S. Committee on Ways and Means, *Hearings*, 51st Cong., 1st sess., 727–730; *Tariff Hearings*, 53d Cong., 1st sess., 1050–1052, 1060, 1063.

[37] Weeks, *History of Paper Manufacturing in the United States*, 302; Twelfth Census, *Reports*, IX, 1024.

industry during these twenty years was due primarily to applications of chemistry that bore fruit in cheaper raw materials; but these were accompanied by corresponding improvements in machinery. America led in devices looking to quantity production. This was particularly true of machines for making news print, the great standardized staple of the industry. In 1872 it was recorded as a remarkable fact that whereas most Fourdrinier machines, which at that time did not exceed 100 inches in width and were usually considerably narrower, ran at a rate of 60 to 80 feet a minute, one mill had speeded up to 175 feet a minute. Before 1897 machines 160 inches wide were in operation, running at a speed of 500 feet per minute, and turning out over 100 tons of paper a week. The maximum product per mill unit had risen 400 per cent within 30 years.[38]

The manufacture of paper hangings, which dates back to colonial days, was a distinct branch of the larger industry, by virtue both of the special type of paper it employed and of the important place that the printing process, with its attendant features of colors, design and seasonal fashions, occupied in its method of production and its marketing problem. Like most industries having an art aspect, it was centered near our larger eastern cities, all but four of the 27 mills reported in 1890 being in New York and Pennsylvania. In 1892 the principal manufacturers, encouraged perhaps by their geographical proximity, consolidated as the National Wall Paper Company, with a share capital of $30,000,000. This organization included 20 factories, representing about 60 per cent of the business in the United States. Among its objects, as announced at the time of its formation, was to "avoid the duplication of patterns, which has cost the manufacturers of this country millions of dollars annually." As we shall see later, this essay in combination did not meet the hopes of its promotors.[39] The technical progress of the industry between 1873 and 1893 was represented principally by improvements in printing machinery that made it possible to apply the ground colors and the patterns at a single operation, and that simplified the mechanical production of certain effects, especially where bronze powders were employed.[40]

The manufacture of straw board was also a thriving branch of the paper-making business in its broader definition. Not only were raw materials abundant in the United States, but the country afforded a large domestic market for its product. Americans were among the earliest large consumers of package groceries such as cereals, put up in cardboard containers. They were likewise the first to appreciate the convenience of standardizing hardware packages and marketing other merchandise in small units packed in individual cartons. A hundred new channels of this kind, which the present generation takes as a matter of course forgetting that they are

[38] Weeks, *History of Paper Manufacturing in the United States*, 294–295
[39] *Commercial and Financial Chronicle*, LV, 216, Aug. 6, 1892.
[40] Depew, *One Hundred Years of American Commerce*, II, 507.

only a few decades old, have added vastly to the uses to which the products of our paper mills are put.

About the time the wave of western settlement broke through the forested areas of the Appalachians and the interior river valleys to the open prairies, which were devoid of timber and afforded no other local construction materials, building paper, both in its untreated form and as tar paper and roofing paper, began to be used extensively to supplement lumber. Soon the products of the paper mills were almost as indispensable for the carpenter as for the writer. Many straw-board and straw-paper factories were erected in the West, whose grain fields supplied their raw materials, and whose prairie farms and villages furnished them a market. The chief centers of this branch of the industry were in Ohio, Indiana and Illinois. During the late seventies a straw-board mill was erected in California, that after several migrations, due to the invasion of the grain ranches by the fruit orchards, finally became the pioneer of a string of similar establishments along the Pacific coast, operated by the Paraffine Paint Company and supplying building papers and box board for the home builders and the fruit growers of that entire section. In the Middle West, where competition and overproduction had previously encouraged several unsuccessful pooling arrangements among manufacturers, the American Strawboard Company, formed in 1889 with a capital of $6,000,000, became the principal single factor in the industry, though it never was able to control the market.[41]

As the outcome of a convention held in 1878, the American Paper Manufacturers' Association was organized. This body was later rechristened the American Paper and Pulp Association. Its original purpose was to control the market and stabilize prices, but these functions, if ever exercised with any degree of success, soon fell into abeyance. Nevertheless, the Society continued to thrive as a social and technical organization serving the professional and statistical interests of the industry.

[41] Weeks, *History of Paper Manufacturing in the United States*, 305–306; *Commercial and Financial Chronicle*, LVIII, 262, Feb. 10, 1894.

CHAPTER XLII

CEMENT, POTTERY AND GLASS

PORTLAND CEMENT

Among the many industries established during this period that subsequently became important was the manufacture of Portland cement. To be sure hydraulic or natural cement had been made in America for half a century, ever since the construction of the Erie Canal, and its manufacture was already a business of considerable extent; but the fact that the rocks and marls suitable for Portland cement in America differ somewhat in both composition and appearance from those employed abroad delayed the introduction of the latter industry. At length, shortly before the Centennial Exhibition, true Portland cement was manufactured both experimentally and commercially in Pennsylvania, and two firms exhibited this product at Philadelphia. These pioneer makers were already producers of natural cement and merely added the required proportion of limestone to the materials they had employed in manufacturing the former to get the new product.[1] This developed into the dry, or American, process, which was generally adopted by eastern makers, who employed large plants for its preparation. The year after the Centennial, works were erected in Indiana to make Portland cement from local marls, thus initiating the wet process, which was carried on as a rule in smaller establishments widely scattered throughout the country and serving chiefly local markets, but eventually was supplanted almost everywhere by the dry method. No slag cement was made until 1893. Indeed even at the latter date the industry was only on the eve of the great expansion that was to follow the adoption of reënforced concrete construction.[2]

After the production of Portland cement began to make real headway, American makers rapidly improved the technique of its manufacture. In 1889 the Atlas Company at Coplay, Pennsylvania, a pioneer in this branch of the industry, experimented successfully with revolving kilns, which had been patented in England, but had not proved satisfactory in that country. This labor-saving device, reinforced by the use of producer gas and crude petroleum as fuel, greatly reduced the cost of production and increased the output of American plants.[3] The per capita consumption of cement in the

[1] U. S. Centennial Commission, *Reports and Awards*, III, Group II, 150, 154, 159, 172.

[2] *Mineral Industry*, VI, 91 et seq., XI, 88 et seq.; U. S. Tariff Commission, 1882, *Report*, I, 705, 708, II, 2275–2276; Willis and Byers, *Portland Cement Prices*, 76; *cf.* American Society of Mechanical Engineers, *Transactions*, IV, 388–403.

[3] *Mineral Industry*, VI, 107, Willis and Byers, *Portland Cement Prices*, 76–77.

United States is supposed to have about tripled between 1870 and 1890. It was again to triple during the following ten years.[4]

In 1882 the manufacturers of both natural and Portland cement were prominent among the petitioners for additional protection. By this time the "mysteries thrown about the manufacture" had been brushed away. It was known that vast quantities of excellent cement material existed in many parts of the Union and the promising future of the industry was clearly foreseen. The principal centers for making natural or Rosendale cement were in Ulster County, New York, where suitable rock was first discovered in 1823, and in the neighborhood of Louisville, Kentucky. Natural cement had also been made for a long period from rock taken from the Potomac River, by works that supplied a considerable portion of that used by the Government.

By 1876 nearly or quite 2,000,000 barrels of natural cement were already made annually in the United States, but the output of Portland cement hardly exceeded 5,000 barrels. Not even in 1893 had Portland cement overtaken the older product, as it was destined to do later, for though the total cement output of the country had quadrupled, reaching 8,000,000 barrels per annum, less than 600,000 barrels of this amount were made by the Portland process. Nonetheless the technical basis of the latter industry was already laid, and the rapid percentage increase in its product during the years immediately preceding prophesied the immense development that was shortly to follow.[5]

BRICK AND TILE

For obvious reasons the clay-working trades are among the oldest and most widely distributed branches of manufacture in the United States. Even today when improved and cheapened transportation has concentrated most other industries geographically, brick are generally produced near the point where they are used. Indeed their employment in construction is as a rule determined by the proximity of clay and fuel suitable for making them. In 1890 every state and territory of the Union except Alaska, New Mexico and Nevada reported brickyards, whose total product, including tile and sewer pipe, which were often made in the same establishments, accounted for three-fourths of the value of the clay manufactures of the country.[6]

While brick-making, therefore, was almost as widely distributed as town-building, and in many places was still conducted as primitively as in colonial days, nevertheless it was undergoing important development at favored points. Where superior clays, cheap fuel and adequate shipping facilities

[4] *Mineral Industry*, XII, 43.

[5] Tariff Commission of 1882, *Report*, II, 2276; U. S. Committee on Ways and Means, 1893 *Tariff Hearings*, 116, 125, 134, 136; U. S. Bureau of the Census, *Mines and Quarries, 1902*, pp. 839, 842; Sunderland, *Fifty Years of Portland Cement*, in *Philadelphia Record*, Jan. 8, 1923.

[6] Eleventh Census, *Report on Manufactures, Selected Industries*, 530–537.

accessible to extensive and not too distant markets existed in the same locality, the organization and technique of modern factory production appeared. The tendency toward such centralization, both geographical and in larger plants, was encouraged by the introduction of brick-making machinery and the growing demand for specialized products, such as pressed brick, fire brick and paving brick.

The use of brick for street paving is said to have been introduced at Charleston, West Virginia, in 1875. It extended very rapidly, especially through Ohio and the prairie states, where the discovery of oil and natural gas, which were extensively used for fuel, and of new coal deposits, combined with the steady decline of neighboring timber resources, encouraged the larger employment of brick for all structural purposes. The absence of suitable stone for paving in many prairie districts also caused brick to be adopted for the street improvements that the young and growing cities of these regions had begun to demand. By 1893 some 300 towns in the United States had pavements of this material. During the decade ending with 1890 the capital invested in brick and tile works rose from about $28,000,000 to $83,000,000. While Pennsylvania and New York respectively ranked first and second in value of product, Illinois and Ohio were a close third and fourth. All the vitrified and paving brick made in the country were manufactured in Ohio and in the states farther west. But 72 per cent of the total product still consisted of ordinary building brick. Pressed brick and fire brick accounted for 9 and 8 per cent respectively of the entire output.[7]

The manufacture of enameled brick, which are now so extensively used both for ornament and for sanitation, began in America about 1876. For several years all the materials used for glazes were imported, but the domestic brick, which were made from different clays and by a different method from those used abroad, were said to be better than those brought from England. In 1880, the pioneer establishment at Philadelphia was still the only one in the United States, although its market extended as far west as Minnesota.[8] In spite of the prevailing duties, foreign brick competed with those made in the country at many points accessible to tidewater, as they were brought to America as ballast or at lower freights than local producers paid for land transportation to points of consumption. A large manufacture of fire-brick gas retorts, glass pots and similar refractory clay products developed in the vicinity of Pittsburgh and of St. Louis, both of which centers were within reach of excellent fire clays and near the largest industrial consumers of these articles. Indeed Pittsburgh fire brick were shipped by water as far south as the sugar houses of Louisiana, where they

[7] *Mineral Industry*, II, 171, 183; Eleventh Census, *Report on Manufactures, Special Industries*, 536–537; *Engineering Magazine*, XI, 1097, Sept. 1896.

[8] U. S. Centennial Commission, *Reports and Awards*, III, Group II, 238–239; U. S. Tariff Commission, 1882, *Report*, I, 416–418; *cf.*, however, *Van Nostrand's Eclectic Engineering Magazine*, VIII, 408, May 1873; Ries and Leighton, *History of the Clay-Working Industry in the United States*, 19.

met competition from Great Britain. Notwithstanding the fact that the United States has abundant and widely distributed deposits of almost every variety of clay, suitable not only for ordinary brick but also for fire brick, pottery and porcelain, and in spite of a duty of $5 a ton upon imported clays, the total quantity brought from abroad increased rapidly, and by 1893 exceeded 75,000 tons per annum.[9]

Another and similar industry inaugurated during this period was the manufacture of encaustic or inlaid tile, which was permanently established in the United States under English patents in 1877. Earlier attempts to make these tile in America had not proved commercially successful, although glazed tile had been produced at a comparatively early period. But the entire group of clay manufactures subserving architectural requirements, and happily reaching maturity just when the adoption of steel and concrete for structural purposes demanded the very qualities of color, design and fire resistance their products possessed, had to wait upon the substitution of modern machinery and chemical control for the older manual operations and rule of thumb. These products are now manufactured from materials ground, separated, combined and pressed by powerful machines, and burnt in continuous kilns, by what is practically from beginning to end an uninterrupted mechanical process.[10]

POTTERY AND PORCELAIN

Pottery and allied clay products were made in forty states and territories in 1890, but ever since the Civil War or earlier two well-defined centers of this industry had existed in America—at Trenton, New Jersey, and East Liverpool, Ohio. During the earlier years of the period we are now considering, Cincinnati, which has remained an important producer of certain art wares, and Green Point and Flushing on Long Island, where the oldest porcelain works in the United States were situated, were secondary centers of importance. Both Trenton and East Liverpool were favored by the proximity of raw materials, including cheap fuel; but East Liverpool makers had easy access to rather better clays and depended more upon domestic supplies than their fellow potters in New Jersey. The latter used English clays to some extent for their finer wares, as did the porcelain works at Green Point, partly because these could be imported, in spite of the duty upon them, at a lower price, including freights, than the best clays from the South and West commanded. East Liverpool also enjoyed the protection afforded by the cost of transporting fragile imported goods from the seaboard to the growing markets of the West.[11]

[9] U. S. Tariff Commission, 1882, *Report*, I, 1192, II, 2161–2164; Committee on Ways and Means, 51st Cong., 1st sess., *Hearings*, 475; *Mineral Industry*, II, 183; Bureau of the Census, *Mines and Quarries, 1902*, p. 860.

[10] U. S. Centennial Commission, *Reports and Awards*, III, Group II, 95–96; Depew, *One Hundred Years of American Commerce*, I, 292–293; U. S. Commissioners to the Paris Exposition of 1878, *Reports*, III, 225; U. S. Tariff Commission, 1882, *Report*, I, 857–863; Ries and Leighton, *History of the Clay-Working Industry in the United States*, 20–25.

[11] Eleventh Census, *Report on Manufactures, Selected Industries*, 508, 514; U. S. Tariff Commission, 1882, *Report*, I, 623–625, 871, II, 1949–1951; American Iron and Steel Association, *Bulletin*, X, 323, Dec. 6, 1876.

The Centennial Exposition of 1876 appears to have influenced the manufacture of china and porcelain much as it did that of furniture, paper hangings and certain tapestries and other fabrics, by encouraging the production of more artistic wares. Until then American decorated goods were limited largely to chamber sets and other coarser articles. To be sure elaborately embellished pottery, sometimes of doubtful taste, was made in this country for special purposes; but the popular demand for light, graceful and artistically decorated tableware of domestic manufacture dates from that event. Partly in response to the improvement in the public taste, and partly on account of the higher duties laid upon decorated china in 1883, the manufacture of this class of goods increased rapidly during the following decade.[12]

By the early seventies the best American potteries had adopted power-driven machinery for many operations. The clays instead of being mixed with paddles by hand and strained in hand sieves, as was still the custom in most British potteries and in not a few of those in America operated by recent immigrants, was worked by steam-rotating paddles in a large slip vat, from which it was transferred by steam pumps to sieves which were also shaken by steam power. The principal plant of the sixteen in Trenton in 1875 covered an area of four acres and was housed in brick buildings several stories high. This factory procured its common clay from New Jersey, and that of finer quality from Pennsylvania, Missouri, South Carolina and Illinois, the finest of all coming from the last of these states. Among other raw materials used at Trenton were flint from Maryland, feldspar from Maine, zinc from Pennsylvania and cobalt from the neighboring nickel works at Camden. Practically no goods were shipped abroad, but consignments were sent to California around the Horn.[13]

Of the 170 pottery kilns reported in the United States in 1876, Trenton had 57, East Liverpool 46, Cincinnati 12, and Flushing and Green Point, Long Island, 11. Besides these kilns, of which 140 produced white ware exclusively, there were a large number in unrecorded establishments, not members of the United States Potters' Association, that were making terra cotta and yellow and Rockingham ware.[14] Three years later East Liverpool reported 8 works making Rockingham ware, besides 2 door-knob potteries and 4 decorating establishments. This district contained 105 kilns and natural gas was used as fuel. Trenton had at this date 29 separate plants, operating an aggregate of 153 kilns. At that city likewise were several companies employed exclusively in decorating. These two centers were estimated to make nearly half of all the pottery produced in the United

[12] Great Britain, *Reports on the Philadelphia International Exposition*, I, 51; U. S. Tariff Commission, 1882, *Report*, I, 620, 865, 869; U. S. Commissioners to the Paris Exposition of 1900, *Reports*, V, 534; American Iron and Steel Association, *Bulletin*, XXIII, 300, Oct. 30, 1889.

[13] American Iron and Steel Association, *Bulletin*, VIII, 353, Nov. 26, 1874; IX, 28, Feb. 5, 1875.

[14] American Iron and Steel Association, *Bulletin*, X, 323, Dec. 6, 1876.

States, a proportion that had fallen to less than a third, possibly on account of more accurate statistics, ten years later.[15]

New deposits of kaolin were constantly being discovered and mills were established at several points for washing, drying and grinding this material before shipping it to the manufacturers. Some difference of opinion existed among potters as to the relative superiority of English and American clays, especially for making true porcelain, or "French China," which was manufactured during the seventies only at Green Point, Long Island, and by one firm at Trenton.[16] Another point of controversy, this time between importers and manufacturers, was over the alleged crazing of American ware.[17] But the progress of the industry was so rapid that these contentions were soon settled, partly by changing conditions, in favor of domestic producers.

In 1875 the United States Potters' Association was organized, upon the initiative of an earlier local body, the Manufacturing Potters' Association of Trenton. It originally embraced about 40 firms, including all the makers of white ware in the country. Like most similar trade groups formed at this period it was largely interested in securing tariff protection for its products; but it also enforced or recommended uniform trade contracts and gave attention to standardizing wares and improving processes of manufacture. In 1892 an amalgamation of the Trenton potteries was brought about, under the name of the Trenton Potteries Company.[18]

In no field of American industrial art did a more important and original development occur during these twenty years than in the production of purely artistic pottery, where the materials serve primarily as a medium of expressing creative beauty instead of supplying utilitarian needs. This movement started in 1880 with the establishment at Cincinnati, of the Rookwood Pottery by Mrs. Maria Longworth Storer, a wealthy patroness. Here native artists, employing domestic clays, created an original type of underglaze decorated faience. This ware won a gold medal at the Paris Exposition of 1889, where the Rookwood Pottery exhibited the earliest of all the crystalline glazes, now widely known. The establishment immediately became commercially self-supporting and continued to prosper and expand by virtue of the high artistic standards it maintained.[19] Naturally these specialties did not bulk large in the great mass of commoner goods that formed the staple product of American potters. Neither are

[15] *Chicago Journal of Commerce*, Sept. 10, 1879, quoted in American Iron and Steel Association, *Bulletin*, XIII, 242, Sept. 24, 1879; *id.*, XV, 225, Sept. 7 and 14, 1881; Tenth Census, *Report on Manufactures*, 76, 322, 422; Eleventh Census, *Report on Manufactures, Selected Industries*, 508.

[16] American Iron and Steel Association, *Bulletin*, X, 323, Dec. 6, 1876; U. S. Tariff Commission, 1882, *Report*, I, 614, 623, 625, 864–865; II, 1949–1951, 1985.

[17] U. S. Tariff Commission, 1882, *Report*, I, 754, 865, 871; II, 1984, 2404.

[18] American Iron and Steel Association, *Bulletin*, IX, 13, Jan. 22, 1875; XIII, 299, Nov. 26, 1879; U. S. Commissioners to the Paris Exposition of 1878, *Reports*, III, 194; U. S. Tariff Commission, 1882, I, 755; *Commercial and Financial Chronicle*, LVI, 288, Feb. 18, 1893.

[19] U. S. Tariff Commission, 1882, *Report*, I, 868–869; U. S. Commissioners to the Paris Exposition of 1889, *Reports*, II, 302; U. S. Commissioners to the Paris Exposition of 1900, *Reports*, V 534–537.

the fine porcelains of France, Germany, or Great Britain representative of wares ordinarily made in those countries. Nonetheless such achievements mark an epoch in a nation's industrial development.

Another aspect of America's advancing civilization was registered in a modest footnote of the report on this industry in the Eleventh Census, recording the fact that sanitary ware to the value of some $1,200,000 was manufactured in New Jersey, and in another item stating that electric conduits valued at $53,500 were produced the same year.[20]

GLASS MATERIALS

Although glass-making was one of the first arts practiced in the colonies and was a well-established industry during the first half century of the Republic, and although machinery for making pressed glassware was an American invention, there was a period following the Civil War when the glass works of the United States were admittedly behind those of Europe, not only in the perfection of their product but also in the technical devices that cheapen costs of production. An abundance of fuel in America retarded the general adoption of the Siemens furnace, which had been introduced at Pittsburgh in the early sixties, and most American glass-makers still clung to the tools and processes of their ancestors.[21] This was partly due to the same causes that delayed the technical progress of iron-smelting during the middle decades of the century—the dispersion of the industry in many small plants serving local markets and protected from competition by a high tariff, and also by the cost of transportation and the heavy loss from breakage upon imported glass.[22]

American glass makers were peculiarly favored in respect to raw materials. The domestic sands are probably purer than those of Europe. Some of the finest glass exhibited by British makers at the Crystal Palace Exhibition in 1853 owed its excellence to the fact that it was made from sand brought from the Berkshire Hills of Massachusetts. Remarkably pure deposits exist in New Jersey, West Virginia, Indiana, and along the upper Mississippi as far South as St. Louis, where a very remarkable deposit was developed in the early seventies.[23] Missouri, likewise, supplied fire-resisting clays which manufacturers, not likely to exaggerate their advantages under such circumstances, testified before the Tariff Commission of 1882 were superior to any obtained in Europe. Nevertheless as late as 1890 German clay was still imported to use in making glass pots. Clays sufficiently refractory for this purpose were widely distributed, however, and it was the general practice in America to make the pots in the glass works themselves.[24] Lime,

[20] Eleventh Census, *Report on Manufactures, Selected Industries*, 520, 522.

[21] In 1878 only three American plants had Siemens furnaces: U. S. Commissioners to the Paris Exposition of 1878, *Reports*, III, 353, 364; *Engineering Magazine*, IV, 884, Mar. 1893.

[22] U. S. Tariff Commission, 1882, *Report*, II, 1999–2000.

[23] Tenth Census, *Report on Manufactures*, 1064; U. S. Commissioners to the Paris Exposition of 1878, *Reports*, III, 314–315.

[24] Tenth Census, *Report on Manufactures*, 1077–1079; U. S. Commissioners to the Paris Exposition of 1878, *Reports*, III, 327 328; U. S. Tariff Commission of 1882, *Reports*, II, 2139; U. S. Committee of Ways and Means, *Hearings*, 51st Cong., 1st sess., 432–434.

flint, lead and most other fluxes and minor constituents except soda, were also supplied in reasonable abundance from domestic—and for the most part neighborhood—sources.

Although the glass works of the colonies and the early Republic had the advantage of being situated in one of the great potash-production regions of the world, the exhaustion of our forests deprived the glass makers of the period we are now describing of this resource. Most of the soda used for industrial purposes in the United States was at this time imported from Great Britain. Indeed, such modest quantities of the industrial alkalis as were made in the United States were either by-products obtained in the manufacture of other chemicals or were produced specifically for the use of glass works. The first large establishment for making carbonate of soda from salt was erected at Wyandotte, Michigan, by Mr. J. B. Ford, a leading plate-glass manufacturer.[25]

BOTTLE MAKING

Probably the earliest glass made in America was ordinary green or bottle glass, and this branch of the industry was the most widely distributed and firmly established as well as the oldest in the country. The consumption of bottles has multiplied remarkably during the last two generations. Glass containers for beverages, fruits and preserves, patent medicines, kerosene, olive oil, palm oil and a great number of substances either unknown to our forefathers or at least not in common use among them, are now employed in almost unlimited quantities. Formerly made by a tedious hand process, they are now for the most part blown by machinery. There was a brief period in the early seventies when large quantities of bottles—forty or fifty carloads in a single consignment—were imported from Germany and Belgium, coming over uncased in the holds of returning grain and cotton steamers, practically as ballast. German bottles were said to be used extensively about 1882 by Milwaukee brewers. This was an instance where the rapid improvement and cheapening of transportation created a new competitive condition. An amendment to the tariff law in 1883, imposing higher duties on foreign bottles, followed a little later by mechanical improvements in American bottle works, enabled our makers to recover control of the domestic market.[26]

WINDOW GLASS

Second only to bottle making in length of history in America is the manufacture of window glass. Here domestic producers never had an uncontested market; and large quantities of this glass were imported from England

[25] Tenth Census, *Report on Manufactures*, 1070; U. S. Tariff Commission of 1882, *Report*, I, 938; Catlin, *The Story of Detroit*, 660; Depew, *One Hundred Years of American Commerce*, I, 281; U. S. Committee on Ways and Means, *Hearings*, 51st Cong., 1st sess., 430–431.

[26] U. S. Tariff Commission, 1882, *Report*, I, 1057, II, 2510; U. S. Committee on Ways and Means, *Tariff Hearings*, 53d Cong., 1st sess., 171–172.

and Europe until a comparatively recent period. Wages were so much higher in the United States than abroad as to raise production costs, especially in markets near the seaboard, above the point compensated by customs duties. Under such conditions the development of labor-saving devices was relatively more favorable to American makers than to their foreign rivals.

The introduction from Europe of the tank system of melting glass and the employment of natural gas in glass works, especially benefited domestic producers. Within a few years the quantity of glass that could be kept molten and in the process of refining by a single furnace increased from 6 tons or thereabouts to 1,000 tons. This caused the manufacture of window glass to become centralized at large works, producing at much lower cost than previously. The first tank furnaces set up in this country were built at Jeannette, a short distance east of Pittsburgh in 1888, and went into operation the following spring. They were the largest furnaces in the world at that time. Although American glassmakers had waited more than twenty years after the introduction of this improvement abroad to adopt it, within six years of that date more than half the window glass made in the United States was melted in tanks.[27]

GLASSWARE

American makers early attained unusual skill in the manufacture of ordinary glass ware, especially the molded goods produced by processes invented in this country, and such ware was probably more largely used in American households than anywhere else in the world. Domestic sands produced a glass of unusual brilliancy and clearness and devices for pressing were much better than those used abroad. During the middle sixties the development at Wheeling of new mixtures, in which soda ash and lime replaced lead and the other fluxes previously employed, reduced the cost of making the glass itself two-thirds; and partly in response to this improvement the manufacture of pressed ware tended to shift from its original home in New England toward the West.[28]

Manufacturers of pressed glass were practically the only members of the industry who did not ask for additional protection when the Tariff Commission of 1882 held its hearings. According to one witness, the reason for this was that our makers had perfected—

> "a great many improvements and appliances of American invention, such as superior machinery and furnaces, larger pots, and cooling the molds by blasts of air, which equalize the difference between the low wages paid abroad and the higher wages paid in this country."[29]

[27] U. S. Commissioners to the Paris Exposition of 1878, *Reports*, III, 355–356; Depew, *One Hundred Years of American Commerce*, I, 281–282; U. S. Committee on Ways and Means, *Hearings*, 51st Cong., 1st sess., 426–427; *Engineering Magazine*, IV, 887, Mar. 1893.

[28] U. S. Commissioners to the Paris Exposition of 1878, *Reports*, III, 244, 365; Depew, *One Hundred Years of American Commerce*, I, 277, 279.

[29] U. S. Tariff Commission, 1882, *Report*, II, 2137–2138.

In the early seventies works were erected at Rochester, Pennsylvania, for the manufacture of a single specialty, goblets and tumblers. So successful were they in their peculiar field that finding the home market dull during the period of trade contraction following the panic of 1873, they began to ship their goods abroad and soon acquired a large foreign market, especially in Great Britain. English papers occasionally commented with considerable puzzlement upon the fact that in spite of high freights and of high labor costs in America, Great Britain was sending soda to western Pennsylvania for the manufacture of glass ware, which was shipped back to Great Britain and sold at lower prices than English makers could afford to meet in their own neighborhood market.[30]

But precisely the opposite condition existed in respect to cut glass, where nine-tenths or more of the cost of an article represented the wages of highly skilled workers. This branch of the industry was reported in 1882 to be declining, and though no definite statistics were cited to confirm that contention, it presented, in contrast to the manufacture of pressed ware, a typical illustration of the disadvantage under which artistic and manual methods of production labored in the United States.[31]

LAMPS

Among the numerous new requisitions made upon American industry by the advent of petroleum was a demand for glass lamps, lamp shades and lamp chimneys. This was followed a couple of decades later by another set of adaptations in response to the invention of the incandescent electric light and accompanying improvements in illumination. Pittsburgh at once became a great center for the production of lamp chimneys, and some of the largest firms in the country were engaged exclusively in this and allied branches of the industry. For many years domestic producers had to meet active competition from Europe, although they simultaneously shipped abroad their own wares of better grade. The output was very large, exceeding at the time the Tenth Census was taken 30,000,000 chimneys per annum in the state of Pennsylvania alone, and several labor-saving devices were introduced in their manufacture.[32]

PLATE GLASS

The most important achievement of American glass makers during this period, however, was the successful establishment of the manufacture of polished plate glass in the United States. The pioneer works, which had been erected at New Albany, Indiana, before the panic of 1873, survived, although they lost $600,000 during the six years ending with 1879; and it

[30] American Iron and Steel Association, *Bulletin*, XI, 67, Mar. 7, 1877; XIII, 188, July 23 and 30, 1879; U. S. Tariff Commission, 1882, *Report*, II, 2139.

[31] U. S. Tariff Commission, 1882, *Report*, II, 2133–2134.

[32] Macbeth-Evans Glass Company, *Fifty Years of Glass Making*, 29–37; U. S. Tariff Commission, 1882, *Report*, II, 2136–2137; U. S. Committee on Ways and Means, *Hearings*, 51st Cong., 1st sess., 432–433; Tenth Census, *Report on Manufactures*, 1049.

was not until after that date, according to the testimony of their owners, that they began to pay a profit. The second large plate-glass works in the country were established almost simultaneously near St. Louis by Detroit capitalists. This company struggled on for several years without making a profit, but was finally reorganized and proved successful.[33] These two works were just getting on to their feet after ten years of pioneering, and one or two small establishments of the same kind had had a brief history at Louisville and in Indiana, when James B. Ford, who had promoted the pioneer establishment at New Albany, erected a large factory at Creighton, Pennsylvania, in the midst of a district rich in coal and natural gas. With the advantage of the latter fuel, the new works speedily proved successful and were supplemented by another establishment in the same vicinity. Within a few years thereafter, several other factories were established at various points in the western natural gas fields, and America became one of the larger producers, as it was one of the largest consumers, of this material.[34]

Most of the polished plate glass made in this country before 1893 was used for windows and some was of very large dimensions. Naturally the western works were protected in the immense market growing up around them, not only by a sufficient duty but also by high costs of transportation. In fact, it was impossible to ship some of the largest sizes by rail, and in at least one instance plates were transported from Western factories to an eastern destination via the Ohio and Mississippi Rivers and New Orleans.[35]

The reason American makers confined themselves so largely to producing "show window" glass was first of all the existence of an almost unlimited market for it during the great wave of development which swept over the Mississippi Valley states and the Far West accompanying the era of prosperity from 1880 to 1893. In the second place, the most perfect qualities of plate glass, which were used for silvering, could not be completely finished by machinery. At least it was the custom in France to polish out trifling defects by hand. The high cost of labor in the United States prohibited this. Nevertheless some mirror plates were manufactured at North Albany and elsewhere, though not extensively. In 1890 American corporations were engaged in this industry, operating 12 plants and making, when fully employed, about 18,000,000 square feet of plate glass per annum.[36]

Among the specialties of glass manufacturing in this country was the production of tempered or annealed glass by a process invented by a Mr.

[33] American Iron and Steel Association, *Bulletin*, VIII, 349, Nov. 19, 1874; VIII, 369, Dec. 10, 1874; XV, 125, May 18, 1881; XXV, 82, Mar. 25, 1891; Depew, *One Hundred Years of American Commerce*, I, 279–280; Tenth Census, *Report on Manufactures*, 1137; U. S. Tariff Commission, 1882, *Report*, II, 1530–1531.

[34] American Iron and Steel Association, *Bulletin*, XVII, 58, Feb. 28, 1883; XVII, 245, Sept. 5, 1883; XXIII, 275, Oct. 2, 1889; U. S. Committee on Ways and Means, *Tariff Hearing*, 53d Cong., 1st sess., 224; *Engineering Magazine*, IV, 887–888, Mar. 1893.

[35] American Iron and Steel Association, *Bulletin*, XXIII, 275, Oct. 2, 1889.

[36] U. S. Ways and Means Committee, *Hearings*, 53d Cong., 1st sess., 224, 228.

de la Bastie of Paris, in 1875. Works were at once erected in Brooklyn to employ this process. William Cullen Bryant, the poet, was interested in the enterprise. According to an account published in 1877, a plate made of this glass could be thrown into the air about 25 feet and allowed to fall upon a brick floor without breaking, and a nail could be driven into a board with a lamp chimney thus prepared.[37] Throughout this period no small proportion of the skilled labor employed in our larger glass works, especially those for making plate glass, came from abroad.

The influence of the discovery of natural gas and of improved furnaces and mechanical devices made itself conspicuously felt in all branches of glass making during the decade between 1880 and 1890. While the value of the glass manufactured in the United States increased from about $18,500,000 in 1870 to over $21,000,000 in 1880, it rose from the latter sum to more than $41,000,000 in 1890. To be sure, these ratios are affected somewhat by the vanishing premium on gold and the decline of prices during the earlier of these two periods. Yet the value of the plate glass made in the United States increased nearly six-fold between 1880 and 1890 and the value of glassware, which was the leading product in value, nearly doubled. Between 1890 and 1893 the value of plate glass made in the United States rose from less than $5,000,000 to more than $7,500,000 and the total value of our glass manufactures increased from $41,000,000 to $47,600,000.[38]

[37] American Iron and Steel Association, *Bulletin*, XI, 44, Feb. 14, 1877; *cf.*, however, U. S. Commissioners to the Paris Exposition of 1878, *Reports*, III, 340.

[38] Tenth Census, *Report on Manufactures*, 1040; Eleventh Census, *Report on Manufactures, Selected Industries*, 313; Depew, *One Hundred Years of American Commerce*, I, 283.

CHAPTER XLIII

FOOD, DRINK AND TOBACCO

FLOUR MILLING

During the seventies flour milling, which has always been one of the country's largest and most widely distributed industries, received two notable improvements from abroad. These were the middlings purifier, a French invention brought to Minneapolis in 1870, and the roller process, already familiar in Europe for nearly half a century, which was introduced in the same city four years later. The new method of milling thus inaugurated consisted in multiple grinding with reduced speed and pressure so as to prevent heating and discoloring the flour, and to preserve the gluten, lying just beneath the bran, which forms one of the wheat berry's most valuable constituents.[1]

This process was far better adapted to making merchantable flour from spring wheat than the old milling process, and the spring wheat area of the North American continent, lying in the northwestern prairie states, was at this time on the eve of the great development that it witnessed during the next three decades. As early as 1878 a solid train of cars carrying 2,500 barrels of flour reached New York after an unbroken trip from Minneapolis, to make connection with a steamer which would deliver the consignment in London sixteen days from the time it left the Falls of St. Anthony.[2] In 1881 Minneapolis manufactured 3,125,000 barrels of flour. Three years later its annual output was 5,100,000 barrels, and by 1890 it manufactured flour-mill products to the value of nearly $31,000,000.[3] But though that city had by this time become the greatest flour-milling center in the United States and probably in the world, that did not imply a greater relative centralization of the industry, so far as we can form an estimate from our inadequate statistics, than existed at an earlier date when Richmond or Philadelphia or some other eastern town was equally prominent as a center of this industry.

Several efforts were made to combine the flour mills of a particular city in a giant corporation or trust. English capital was back of some of these

[1] Robinson, *The Wealth of Minnesota*, 103–104; *Northwestern Miller*, quoted in American Iron and Steel Association, *Bulletin*, XVI, 179, July 5, 1882; U. S. Commissioners to the Paris Exposition of 1889, *Reports*, IV, 516–517.

[2] American Iron and Steel Association, *Bulletin*, XII, 133, June 5, 1878.

[3] American Iron and Steel Association, *Bulletin*, XVII, 195, July 18 and 25, 1883; XX, 157, June 16, 1886; Eleventh Census, *Report on Manufactures*, II, 345.

schemes, partly perhaps because British importers were interested in the American flour trade and were encouraged by their familiarity with the distribution of the product to ultimate consumers to extend their control to grain buying and milling.[4] Parenthetically, a similar trend toward consolidation also appeared about this time in the principal flour-using industry, when shortly before 1893 a large number of bakeries producing crackers, gingersnaps and other package goods were amalgamated, as the New York Biscuit Company, which had 14 factories in New York, Chicago, Boston, Philadelphia and smaller eastern towns.[5]

BREWING AND DISTILLING

Brewing and distilling, our two other largest grain-using industries, at this time resembled flour milling in the wide distribution of their establishments, combined with a notable degree of centralization at a few urban centers, where they formed one of the dominant or representative industries. Milwaukee and St. Louis were famous brewing cities; Peoria was a noted distilling center, and a Kentucky county gave its name to Bourbon whisky. Yet there was hardly a town of more than 10,000 people in the grain-producing states, or at any point to which malt could readily be shipped, that did not at this time have a brewery. Presumably distilling would have been equally widely distributed had the organization of this industry not been influenced by the provisions of the internal revenue law.[6]

The high tax on distilled liquors, which was subject to change or to threat of change at almost every session of Congress, gave this business a highly speculative character, and made many fortunes and caused many failures among those engaged in it. This is illustrated by the checkered career of the "Whisky Trust," to call by its popular name what was known in sober financial circles as the "Distilling and Cattle-Feeding Company." This corporation, which had been preceded by an unsuccessful pool, was organized in 1887 with a capital stock of $35,000,000 and owned 85 distilleries in addition to cattle sheds and other plants associated with the distilling business. Its sales exceeded 40,000,000 gallons of spirits a year, and at times its profits were very large. In 1892, however, this Company, anticipating an increase in the internal revenue tax, acquired additional establishments and pushed its manufacturing operations to the utmost, speedily accumulating three times the normal amount of liquor in its warehouses in expectation of a sharp rise in prices. It also added 20 cents a gallon to the price of its goods. The expected law was not enacted, and the Company soon found itself involved in financial difficulties due to locking up its capital in an excessive quantity of unsalable liquor and to a sharp lessening of demand for its product on account of the hostility which

[4] This was particularly true of Minneapolis; for consolidations at St. Louis and New York, *cf.*, American Iron and Steel Association, *Bulletin*, XXIV, 2, Jan. 1 and 8, 1890; *Commercial and Financial Chronicle*, LV, 215, Aug. 6, 1892.
[5] *Commercial and Financial Chronicle*, LVIII, 304–305, Feb. 17, 1894.
[6] *Cf.* Bogart and Thompson, *The Industrial State*, 407.

its price policy evoked. The effect of that policy was not remedied when the Trust attempted to organize an independent distributing system, through which it hoped to establish direct relations with ultimate consumers. The directors discovered that buying out competing distillers merely encouraged new rivals to enter the industry. In 1893 every establishment owned by the Trust was closed down until the stocks in its warehouses could be reduced. The Company was attacked in court by the Government under the anti-trust law. Altogether, this effort to monopolize the distilling business of the country proved a failure and the Company eventually passed into the hands of a receiver and was reorganized.[7]

About 1885 corn, which had always been used extensively in the manufacture of certain grades of whisky, began to be substituted where rye was previously employed. The cheaper grain could now be used in place of its costlier rival on account of improvements in the machinery for preparing it for distillation.[8] Rum distilling survived in New England, and over 1,000,000 gallons were exported annually from Boston to Africa, continuing a trade two centuries old.[9] Another corn-using industry, the manufacture of starch, fell under the control of The National Starch Manufacturing Company, incorporated in Kentucky in 1890, which embraced nearly all of the large factories in the United States. These properties were bought outright for cash, but were run as individual undertakings and retained their former trade-marks. Yet only three years later the Company passed its usual dividend, "on account of excessive competition during the past winter and spring and the present extreme dullness of trade."[10]

MEAT PACKING

Grain distillers were also cattle-feeders, in order to utilize the refuse from their stills, but this tie did not create an economic alliance between distilling and meat packing, or notably encourage the location of distilleries and packing-houses at the same points.[11] Two major changes occurred in the packing industry during the seventies and eighties: the development of refrigeration and canning as preserving processes, partially supplanting the salting and smoking previously employed, and the accompanying swing from pork to beef as the dominant product. These two changes were causally related, but they were also conditioned by other influences, particularly the extension of railways into the western range country, which by reason of its climatic limitation to grazing industries became the country's great reser-

[7] Bogart and Thompson, *The Industrial State*, 408–409; *Commercial and Financial Chronicle*, LIV, 682–683, Apr. 23, 1892; LVI, 621, Apr. 15, 1893; U. S. Industrial Commission, *Report*, I, 77–78, 831–832.

[8] Bogart and Thompson, *The Industrial State*, 371.

[9] American Iron and Steel Association, *Bulletin*, XXV, 219, July 29, 1891.

[10] American Iron and Steel Association, *Bulletin*, XXIV, 61, Mar. 5, 1890; *Commercial and Financial Chronicle*, LVI, 1015, June 17, 1893; U. S. Industrial Commission, *Reports*, XIII, 671–672.

[11] *Cf.* National Association of Wool Manufacturers, *Bulletin*, XII, 140–142, June 1882.

voir of live stock. The grass frontier produced the steer as inevitably as the corn frontier had produced the hog.[12]

Chilling at the packing house, which had become general before 1870, was extended during the following decade to refrigeration in transit, both by rail and by sea. The refrigerator car, and the refrigerator ship with holds cooled by mechanical means, were becoming familiar by the Centennial year, and were destined speedily to revolutionize the fresh-meat trade between the United States and Europe. They also encouraged the further centralization of the slaughtering and packing industry, both geographically and in the hands of large firms or corporations.[13] In 1885 it was estimated that the daily purchases at the Chicago stock yards exceeded $1,000,000.[14]

Both the bacteriological and the chemical laboratory eventually became handmaids of the packing industry, where their service consisted in standardizing quality, creating new products and utilizing waste. The manufacture of by-products, which dates back to the earlier part of the century, was originally a group of allied industries rather than an integral part of the packing business. Before 1875, such products were confined to lard, lard oil, tallow, soap, glue, fertilizer, dressed bristles and prussiate of potash.[15] After the chemist appeared as an active factor in the industry, the list of by-products was rapidly extended and their manufacture fell almost entirely into the hands of the packers, who alone had the necessary agencies of chemical control. The pharmaceutical preparations coming from their laboratories now number nearly fifty; and the list of food products has been extended. The manufacture of oleomargerine, which was invented in France in 1870 and patented in the United States three years later, had become a thriving industry by 1880.[16] A change in the process of canning, which consisted in precooking the meat before it went into the container and in making the latter wedge-shaped so the contents could be removed in a loaf, eliminated the disagreeable taste and appearance of meats cooked in the can and packed floating in their juices, and thus gave a great impetus to this form of food preparation.[17]

CANNING

Other notable improvements in the canning industry were the introduction of the autoclave, which made possible cooking temperatures as high as 500°; the invention of machinery for preparing fruits, vegetables and fish for canning and also for sealing cans; and some progress toward chemical

[12] Clemen, *American Livestock and Meat Industry*, 6–9.
[13] Clemen, *The American Livestock and Meat Industry*, 214, 216, 220, 222; American Iron and Steel Association, *Bulletin*, x, 244, Sept. 13, 1876; xvii, 325, Nov. 21 and 28, 1883.
[14] *Boston Journal of Commerce*, xxvii, 17, Oct. 24, 1885; *cf.* Clemen, *American Livestock and Meat Industry*, 202–203.
[15] Clemen, *The American Livestock and Meat Industry*, 132–133, 348.
[16] Clemen, *The American Livestock and Meat Industry*, 358–361; 369–370.
[17] Clemen, *American Livestock and Meat Industry*, 463–466; Collins, *The Story of Canned Foods*, 153–154.

and bacteriological control of products.[18] Machinery for making cans was likewise perfected, so that by 1885 their manufacture was becoming a separate industry demanding specialized plants.[19] Canneries were built in all parts of the country, but Maryland and California were the leading states in this industry.

In 1891 when the McKinley Law levying a high duty on tin plates was enacted, opponents of protection made much of the argument that this tax would increase the cost of canned goods to consumers.[20] The controversy is chiefly important here as illustrating how large a place this industry already held in the household economy of the people. As a matter of fact the cost of cans had declined, largely in consequence of the introduction of labor-saving machinery, until it was a relatively small item in the retail cost of the food they contained. They were quoted in 1891 at from $1.80 to $3 per hundred.[21]

SALT

Salt-makers—who originally found their market, except for household consumption, almost entirely in the packing industry—have disposed of a growing share of their product during the last half century to chemical manufacturers and ore reduction plants. These new demands, that far more than compensate for the lessened use of salt provisions, have called for an enormous expansion of output. Fortunately several important salt discoveries were made in America during this period. In 1878 the wells in Wyoming County, New York, began producing, and about ten years later another salt field was discovered in central Kansas.[22] The latter discovery, made while boring in search of natural gas, was most opportune for the packing industry at Kansas City and even encouraged the erection of packing houses in Atcheson and Wichita in the immediate vicinity of the wells. Within 18 months Kansas salt displaced all its competitors in the Kansas City market, where it was laid down freight paid for $4 a ton.[23]

While the Kansas region owed its discovery and development to seeking natural gas, the discovery and development of natural gas in Pennsylvania revived the salt industry of that state, for the new fuel so cheapened the cost of evaporation that the deserted wells of that region again became profitable.[24] Michigan salt, in the district first developed during the Civil War, could now be produced for half the cost of salt evaporated at Syracuse or in western New York, because at this period sawdust and other sawmill waste were used for fuel. By 1892 the United States made about 20,000,000 barrels of salt a year, or more than it consumed.[25]

[18] Collins, *The Story of Canned Foods*, 20–23.
[19] Collins, *The Story of Canned Foods*, 34–36.
[20] *Cf.* Stanwood, *American Tariff Controversies*, II, 290–291.
[21] American Iron and Steel Association, *Bulletin*, XXV, 307, Oct. 21, 1891.
[22] *Mineral Industry*, I, 412–418.
[23] American Iron and Steel Association, *Bulletin*, XXIII, 195, July 17 and 24, 1889.
[24] American Iron and Steel Association, *Bulletin*, XIX, 315, Nov. 25, 1885.
[25] *Mineral Industry*, I, 418; U. S. Committee on Ways and Means, *Tariff Hearings*, 51st Cong., 1st sess., 1314.

way intermittently for 25 years and the Government cautiously reported that with wise management, careful control and proper selection of locality, sorghum sugar industry might be financially successful.[29] Nevertheless by 1892 the industry was confined entirely to Kansas, whose citizens received a bounty under the McKinley Bill upon over 1,000,000 pounds of sorghum sugar.[30]

Naturally, the existence of a large and flourishing beet-sugar industry in Europe was known to the farmers of the United States and efforts had been made at intervals for 50 years to establish the industry on this side of the ocean. But American farming methods, the high cost of labor and the fact that early experiments were not always made in favorable localities prevented permanent success. In 1877, Maine offered a bonus of one cent a pound on all beet sugar manufactured in the state and a bounty of $7,000 a year for 10 years in addition as general encouragement for a beet-sugar factory. As a result such a factory was established in a sugar refinery at Portland, Maine, and went into operation in 1880.[31] Delaware likewise made a small appropriation in 1877 to encourage the experimental raising of sugar beets and the legislature recommended state aid to a beet-sugar factory. As a consequence such an establishment was erected near Wilmington, which also commenced operation in 1880.[32] Both this mill and the one in Maine drew their beet supply from a wide area, some coming even from Canada. The same year a mill was reported about to start in Franklin County, Massachusetts.[33] The Portland company ceased operation at the close of the 1881 campaign "on account of the unfitness of the soil for the production of beets," and a new company was organized to transfer the mill to the Mohawk Valley.[34]

All these eastern enterprises, like those in Illinois and Wisconsin ten years or more earlier, eventually failed; but meanwhile a permanent industry was slowly taking root in California, whither the machinery of the first Wisconsin factory was transferred about 1870.[35] Despite one failure of this original enterprise, the manufacture was almost immediately resumed and by 1880 it was on a commercial basis.[36] Thereafter progress, though slow, was sure. In 1883 the Alvarado factory in California made 500 tons and its profits reached 40 per cent.[37] There was an important step forward in

[29] American Iron and Steel Association, *Bulletin*, XVII, 261, Sept. 19, 1883; XVII, 285, Oct. 10, 1883; XVII, 309, Nov. 7, 1883; XXI, 307, Nov. 2 and 9, 1887; XXIII, 269, Sept. 25, 1889; XXIII, 329, Dec. 4, 1889.

[30] American Iron and Steel Association, *Bulletin*, XXVI, 69, Mar. 9, 1892; XXVI, 253, Aug. 31, 1892.

[31] American Iron and Steel Association, *Bulletin*, XI, 53, Feb. 21, 1877; XI, 202, Aug. 1, 1877; XIII, 218, Sept. 3, 1879.

[32] American Iron and Steel Association, *Bulletin*, XIII, 25, Feb. 5, 1879; XIII, 205, Aug. 13, 1879; XIV, 205, Aug. 18 and 25, 1880.

[33] American Iron and Steel Association, *Bulletin*, XIV, 300, Dec. 8, 1880.

[34] American Iron and Steel Association, *Bulletin*, XV, 75, Mar. 23 and 30, 1881; Blakey, *The U. S. Beet Sugar Industry and the Tariff*, 34; U. S. Commissioner of Agriculture, *Report, 1880*, p. 9: *id. Report, 1881*, p. 675.

[35] Blakey, *The U. S. Beet Sugar Industry and the Tariff*, 34.

[36] American Iron and Steel Association, *Bulletin*, XV, 106, Apr. 27, 1881.

[37] American Iron and Steel Association, *Bulletin*, XIX, 58, Mar. 4, 1885.

1888, when Claus Spreckels, a millionaire who had made a fortune raising cane sugar in Hawaii and had subsequently become interested in the refining industry both in California and at Philadelphia, went into this business. His first factory, at Watsonville, California, represented an investment of half a million dollars and its operations were on a scale comparable with that of the large cane-sugar mills of the South.[38] Three years later the Oxnards, already experienced sugar refiners, organized companies and erected large mills in Nebraska and Southern California.[39] The McKinley bounty came at a favorable time to stimulate this movement. In 1891 some 8,000 tons of beet sugar were produced, half at the Spreckels factory at Watsonville, the rest distributed among other mills in that state, Nebraska, Utah and Virginia.[40] In 1892, by which year the crop had risen to nearly 14,000 tons[41] representatives of six beet-sugar factories met in San Francisco and formed an association to encourage the industry, an indication that it was already on a paying basis.[42]

Sugar refining had long since become a highly centralized business confined to a few big companies. Its operations required a large liquid capital, tied up for a part of each season in raw sugar and therefore demanded the banking facilities afforded by a large city. Moreover, refineries could be most economically operated on the coast accessible to their raw materials, which mostly came by sea, and to distributing facilities. New York, Boston and Philadelphia were the refining centers of the Eastern States. New Orleans had refineries both as an importing city and as an adjunct to the Louisiana cane-sugar industry, although the product of the neighboring plantations was largely marketed to consumers in the form in which it came from the mills. Refineries had also been built in California, to refine the Hawaiian crop, which under the reciprocity treaty of 1875 entered this country free of duty. The geographical concentration of the industry, the speculative dangers that attended it when competition between refineries became over-active, the fact that the prosperity of refining depended upon a complex and technical system of import duties and drawbacks,[43] had from an early date encouraged more or less cooperation and close understanding among the refining interests of particular cities and sections of the country.[44] Nevertheless, price wars attended by heavy losses had occurred among refiners. So it was natural that when the trust movement swept over the country in the eighties and nineties sugar refining should be one of the first branches of business affected.

[38] American Iron and Steel Association, *Bulletin*, XXI, 138, May 25, 1887; XXI, 317, Nov. 16, 1887; XXII, 5, Jan. 4, 1888; XXIII, 219, Aug. 14, 1889; XXIV, 149, May 28, 1890.

[39] Blakey, *The U. S. Beet Sugar Industry and the Tariff*, 35; American Iron and Steel Association, *Bulletin*, XXIV, 117, Apr. 23 and 30, 1890; XXIV, 293, Oct. 15, 1890; XXIV, 317, Nov. 5, 1890; XXIV, 371, Dec. 31, 1890; XXV, 245, Aug. 19, 1891.

[40] American Iron and Steel Association, *Bulletin*, XXV, 218, July 29, 1891.

[41] U. S. Commissioner of Agriculture, *Report, 1892*, 467.

[42] American Iron and Steel Association, *Bulletin*, XXVI, 33, Feb. 10, 1892; XXVI, 82, Mar. 23 and 30, 1892.

[43] *Cf. Commercial and Financial Chronicle*, XXII, 98–100, Jan. 29, 1876; Vogt, *The Sugar Refining Industry in the United States*, 26–33.

[44] Vogt, *The Sugar Refining Industry in the United States*, 34–35.

The initial attempt to consolidate and monopolize the industry occurred in 1887 when the "Sugar Refineries Company" was organized. This was a trust, controlling sixteen of the principal refineries—in fact all in the country with the exception of two in Philadelphia, one in Boston and one in San Francisco.[45] Spreckels was at this time fighting the Trust, and had recently erected one of the independent Philadelphia establishments which was reported to be the largest in the world.[46] The Sugar Refineries Company was attacked in the courts by the Federal Government for violating the Act of Congress prohibiting trusts and monopolies, and was placed in the hands of its own organizers as receivers.[47] This caused it to be dissolved in 1890 and to be succeeded by an ordinary corporation which took over all its properties. The new corporation, "The American Sugar Refining Company," had a capital of $50,000,000 and it immediately made terms with Spreckels and other outsiders that gave it virtual control of the refining business of the country.[48] Its secretary and treasurer, testifying in a Federal suit to dissolve the Company in 1893, stated that it refined 90 per cent of all the sugar refined in the United States. Only five wholly independent establishments were in operation, one at Boston and four at Philadelphia. A majority of the refineries owned by the new company were closed down and in some instances dismantled; so that the effect of unified control was to concentrate the business in fewer and larger establishments.[49]

Glucose, or sugar made from starch, became an important industrial product during this period. The chief seat of the early manufacture was at Buffalo, where thousands of bushels of corn were converted into starch which was treated with sulphuric acid to produce a sugar which could be marketed at from 2 to 3 cents a pound, or very much below the cost of cane sugar or beet sugar. It was much used by confectioners and brewers, and as bee-food and in making artificial honey, but principally in the manufacture of syrup. In 1880 there were 7 glucose factories in the country with a product valued at $4,500,000, or equal to about one-third that of the cane-sugar crop.[50] Ten years later the chief seat of the industry was Illinois, and the product had increased to $7,757,000.

[45] Vogt, *The Sugar Refining Industry in the United States*, 35–36; Van Hise, *Concentration and Control*, 147; American Iron and Steel Association, *Bulletin*, XXII, 117, Apr. 11, 1888.

[46] American Iron and Steel Association, *Bulletin*, XXIII, 209, Aug. 7, 1889; Vogt, *The Sugar Refining Industry in the United States*, 43–45.

[47] *Commercial and Financial Chronicle*, XLIX, 617, Nov. 9, 1889; LI, 646, Nov. 8, 1890; LI, 681, Nov. 15, 1890; Vogt, *The Sugar Refining Industry in the United States*, 42–43.

[48] *Commercial and Financial Chronicle*, LI, 115, July 26, 1890; LII, 120–121, Jan. 17, 1891; LII, 535, Apr. 4, 1891; Van Hise, *Concentration and Control*, 148.

[49] *Commercial and Financial Chronicle*, LV, 177, July 30, 1892; *cf.*, however, Vogt, *The Sugar Refining Industry in the United States*, 48.

[50] Tenth Census, *Statistics of Manufactures*, 999, 1001, 1002 (*Report on the Manufacture of Chemical Products and Salt*, 9, 11, and 12 footnotes); *Popular Science Monthly*, XIX, 251, June 1881.

TOBACCO

The salient facts in the development of the tobacco manufacturing industry during these 20 years were the remarkable increase in the output and consumption of cigarettes, the development of a large tobacco manufacturing center parallel with the growth of the cigarette industry at the new town of Durham, North Carolina, and in its vicinity,[51] and the organization in 1890 of the American Tobacco Company, with a capital stock of $25,000,000 for the purpose of combining the principal tobacco factories in the country, of purchasing and curing leaf tobacco and of distributing the finished products.[52]

Between 1870 and 1890 the American crop of leaf tobacco rose in round numbers from 263,000,000 to 488,000,000 pounds, well toward half of which was raised in Kentucky. Cigar-making remained throughout this period a widely dispersed industry, employing practically no labor-saving machinery; and during the twenty years ending with 1895 the increase in size of establishments, measured by output, averaged only 10 per cent.[53] But other branches of tobacco manufacturing, where machinery was employed and merchandizing conditions made a larger capitalization advantageous, showed the tendency toward concentration manifested in most other industries.[54]

Manufacturing also became centralized in large cities having a cheap labor supply and near the tobacco-raising country. Thus in 1890 St. Louis, Louisville, Richmond and Cincinnati were in the order mentioned the principal centers for making plug tobacco. The industry in Richmond was of ancient date; and the other cities mentioned were immediately accessible to the Burley leaf growers of Kentucky, Tennessee and Ohio. New York City was the largest producer of cigarettes, and Rochester, in the same state, was an important cigarette-making city, but Durham and Winston in North Carolina, and Richmond, Virginia, situated in the heart of the cigarette tobacco country, were relatively to their population, more highly specialized centers of this manufacture.

The American Tobacco Company grew up around the most completely mechanized branch of the industry, the manufacture of cigarettes. Indeed it was the introduction of improved machinery, about this time, that encouraged the excessive competition which ended in consolidation. Nor did the Company extend its operations beyond this branch of the industry until after the period we are describing.[55]

[51] *Industrial South*, VI, 353, Aug. 1886; Hillyard, *The New South*, 140.
[52] *Commercial and Financial Chronicle*, LI, 349, Sept. 13, 1890.
[53] Jacobstein, *The Tobacco Industry in the United States*, 87.
[54] Jacobstein, *The Tobacco Industry in the United States*, 95; *cf.*, however, Bogart and Thompson, *The Industrial State*, 410.
[55] Jacobstein, *The Tobacco Industry in the United States*, 102–104.

CHAPTER XLIV

INDUSTRIAL FUELS AND MISCELLANEOUS MANUFACTURES

COKE

Although coke was made in the United States before the Civil War and was a fuel of some industrial importance during that conflict, its manufacture, if we may dignify by that name the crude method of producing it then employed, was still in its infancy. Indeed as late as 1879 considerable coke was made in pits, in ricks, or even "on the ground," with no more apparatus than the charcoal burner used; nor had this primitive and wasteful method entirely vanished at the close of the period we are now describing.[1] During the early seventies the Connellsville district made, as it continued to do later, most of the coke produced in the country, supplying chiefly the blast furnaces and foundries of Pittsburgh and its vicinity. As soon as railroads had been built into the Rocky Mountain states coke was shipped thither to smelt silver ore. In fact Cardiff coke was imported at San Francisco for this purpose, though it cost in some cases $40 a ton by the time it reached its destination. But Western smelters afforded a relatively minor market for this commodity, and the great expansion of coke making was due to the demands of Eastern and Southern iron-makers. Indeed the proximity of the Connellsville field was one of the principal ties retaining the great blast furnace and steel-making center of the Union near the headwaters of the Ohio after 1873, when Lake Superior ore began to be employed extensively for producing Bessemer pigs. In 1876 the coke ovens of this district had an annual capacity of about a million tons; four years later the number of ovens approached 8,000 with an output of over 2,000,000 tons, and by 1890, when there were 15,000 ovens, the product was more than 5,500,000 tons.[2]

Coke quotations fluctuated widely within short intervals on account of the varying seasonal demands of the blast furnaces and alternating periods of over-activity and stagnation in the iron industry. For instance, the price fell from $5 a ton to $1.50 a ton between January and June 1880; and it even sank to 90 cents a ton in 1883, which was probably less than

[1] Bridge, *Inside History of the Carnegie Steel Company*, 171; American Iron and Steel Association, *Bulletin*, XXVII, 3, Jan. 4, 1893.

[2] *Manufacturers' Record*, LXV, 55, May 21, 1914; American Iron and Steel Association, *Bulletin*, XVI, 21, Jan. 18, 1882; XXVI, 20, Jan. 20 and 27, 1892; Eleventh Census, *Report on Manufactures*, III, 349.

FIG. 1.—Beehive Coke Ovens

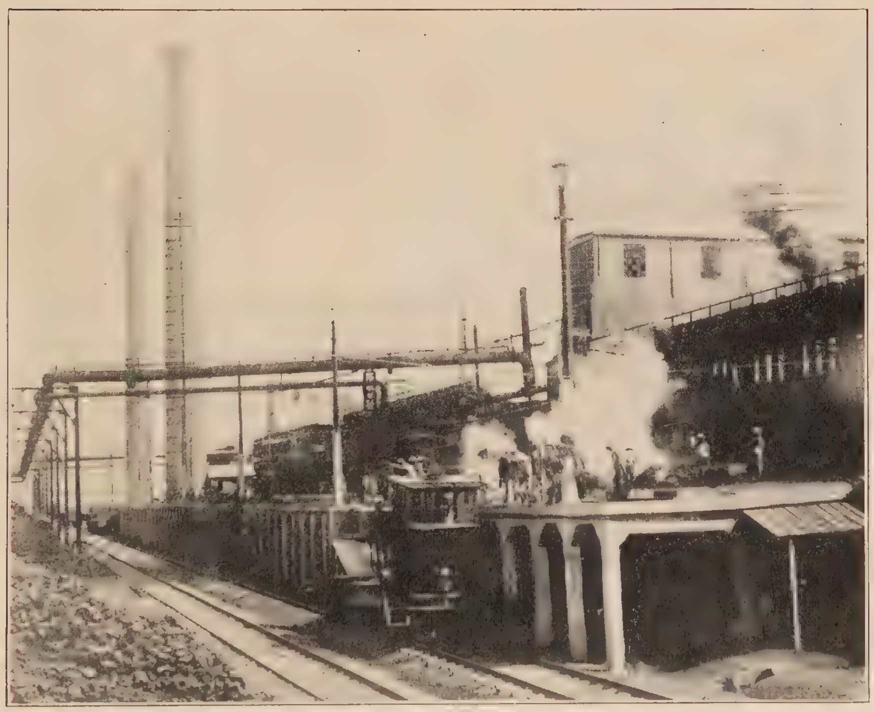

FIG. 2.—Modern Byproduct Coke Ovens

the cost of production.[3] This led to agreements to control output and prices, and to the concentration of ownership in a few hands. Late in 1883 or early in 1884 the Connellsville Coke Syndicate, embracing a subordinate group of small operators, known as the Producers' Association, and several larger firms, was formed to take over the product of a majority of the ovens in the district. This body, which was continued from year to year, dissolved in 1887; but by that date centralization of ownership was making such rapid progress as to reduce the importance of its services.[4]

While coke-making was widely dispersed by 1890, and the census of that year mentioned 13 producing districts in the United States, the Connellsville region, some 50 miles long and 3 miles wide, continued to turn out more than half the total. Alabama, which rose from eighth to second among the states during the last decade of this period, made nearly 1,000,000 tons in 1889, or rather more than one-sixth of the Connellsville output.[5] The first ovens were built there, in the Warrior Field, during the late seventies; they numbered nearly 6,000 in 1893. Between 1880 and the latter date the proportion of the coke manufactured in the country produced by the South increased from about one-tenth to nearly one-third, and the quantity of coke made in the Union annually rose from 3,338,000 tons to over 12,000,000 tons.[6]

Throughout this period most of the coke made in the United States was produced in beehive ovens, whose shape was indicated by their name, varying from 11 to 12 feet in diameter and from 5 to 6 feet high. The coal was dumped through a hole in the crown of the furnace and spread evenly on the floor to a depth of 2 or more feet. The front opening, through which the coke was discharged, was nearly closed with bricks. The heat retained in the thick-walled oven from the previous coking fired the charge, but complete combustion was prevented by excluding more and more air until it was cut off completely. After coking about 48 hours the charge was drawn. The product of such an oven for each heat was 120 bushels, or nearly a quarter of a ton. In 1879 the cost of making a ton of coke by this process was about $1.15, distributed as follows: maintenance, interest and depreciation, 42 cents; mining coal, 38 cents; drawing coke, 25 cents; loading and handling, 10 cents.[7]

This method of manufacture was wasteful, since the gases, which contain valuable by-products, were lost; but as long as raw materials and other costs were as low as this, little incentive existed to introduce expensive retort ovens. The market for the by-products was limited and was abundantly supplied by city gas works, where the coke itself became a

[3] American Iron and Steel Association, *Bulletin*, XIV, 139, June 9, 1880; XVII, 61, Feb. 28, 1883; XVIII, 13, Jan. 9, 1884.

[4] American Iron and Steel Association, *Bulletin*, XVII, 285, Oct. 10, 1883; XVII, 332, Dec. 5, 1883; XVIII, 93, Apr. 2 and 9, 1884; XX, 253, Sept. 22, 1886; XXI, 45, Feb. 16, 1887; XXI, 61, Mar. 2 and 9, 1887; XXI, 85, Mar. 30, 1887; XXI, 355, Dec. 28, 1887; XXIV, 11, Jan. 15, 1890.

[5] Eleventh Census, *Report on Manufactures*, III, 348–349.

[6] *Manufacturers' Record*, LXVI, 39, Oct. 15, 1914.

[7] American Iron and Steel Association, *Bulletin*, XIII, 125, May 21 and 28, 1879.

by-product. Furthermore the opinion prevailed among iron-makers that beehive-oven coke worked better than retort coke in a blast furnace.[8] A few flue or retort ovens, or "Belgian ovens" as they were known in the trade, had been built in the United States, but they were at this time regarded by Americans as a failure, or at best as a very problematical experiment.[9]

ILLUMINATING GAS

Illuminating gas had been manufactured in America for half a century when its market, even in urban homes and business establishments, was threatened with restricted expansion if not actual curtailment by the introduction of petroleum, which gave more light for less money than the gas then in use. The latter was produced from coal, and in some cases from pine wood, and was much inferior to that supplied today. During the early seventies, however, two inventors, one a Frenchman and the other an American, but both working in the United States, developed independently methods of making water gas. This was produced by disassociating the constituents of water, through passing superheated steam over incandescent coke or anthracite coal, thus forming a mixture of hydrogen and carbon monoxide, both inflammable gases that burn without light, but that may be raised to any illuminating power desired by adding oil vapors. Water gas thus manufactured was first used in Pennsylvania in 1873, and after 1880 rapidly supplanted in many localities that produced by the older process. Petroleum was thus made to subserve the development of its competitor.

About this time, however, two new rivals, natural gas and electricity, appeared, the former restricted to definite geographical areas, but the latter occupying market areas as wide as the country itself. Although gas was at first much cheaper than electricity, the pressure of this threatened competition impelled gas companies to seek new outlets for their product and to encourage the improvement of gas ranges, gas engines and other devices likely to enlarge consumption. Then came the invention of the Welsbach mantle, by a Vienna chemist, in 1885 and 1886, which restored to gas its impaired supremacy as a cheap lighting medium.

Most of the gas manufactured in America has been of higher candle power than that made abroad, partly perhaps because of the keen competition between illuminants in this country. The extensive use of water gas partly explains the relatively minor place held by by-products in statistics of output. In 1890, when 742 city gas works were reported in the United States, less than half of the gas made in the country was produced from coal, and except for coke the only subsidiary products were tar and am-

[8] American Iron and Steel Association, *Bulletin*, XIII, 158, June 18 and 25, 1879; *Mineral Industry*, I, 88–89.

[9] American Iron and Steel Association, *Bulletin*, XXVII, 3, Jan. 4, 1893; Eleventh Census, *Report on Manufactures*, III, 345.

moniacal liquor, whose combined value was but little more than 2 per cent of the total. The amount of fuel-gas manufactured in city service plants at this date was negligible, partly on account of the competition of natural gas, which had a higher heating power than producer gas.[10] Most fuel gas was made in private plants by the consumers and therefore was not included in the census figures. In 1885, when slack coal was sold at the western Pennsylvania mines for 5 cents a ton and could be delivered at Pittsburgh for 30 cents, most of the steel works in that city had apparatus for converting it into gas.[11]

NATURAL GAS

The natural-gas era, which dates from the eighties so far as its larger use as an industrial fuel is concerned, was a novel and in some places a transitory episode in our manufacturing history. When the new fuel first made its appearance it shifted works and factories, called forth new industries in what had hitherto been agricultural communities, and forced coal operators to find new markets outside the area of gas distribution. At the time of its maximum output in Pennsylvania and north of the Ohio natural gas was the preferred industrial fuel from Pittsburgh to eastern Kansas. In the former state it was employed for heating furnaces and making steam at 73 iron and steel works, 69 glass works and over 1,600 other industrial establishments; in Ohio 10 iron and steel works, 31 glass works and 278 other industrial plants used it; Indiana manufacturers employed it in a half-dozen rolling mills, 11 glass works and 439 other plants. It was used to burn brick in Kansas. Thirty-one factories are said to have been located at Findlay, Ohio, between June 1886 and June 1887 for the purpose of utilizing this fuel. But so rapid was the decline when once the wells in this particular district began to fail, that only five years later not more than one-tenth of the factories in Indiana and northwestern Ohio, within the producing area, still used natural gas.[12]

FUEL OIL

Petroleum also made some headway as an industrial fuel during this period. In 1878 a vaporizing device for burning a residuum of petroleum and coal tar in conjunction with superheated steam was tested at the Brooklyn Navy Yard. Nearly nine years later, an oil-burning locomotive, run over the Pennsylvania Railroad from Altoona to Pittsburgh, was reported

[10] Depew, *One Hundred Years of American Commerce*, I, 297–299; Eleventh Census, *Report on Manufactures*, III, 699, 705; *Mineral Industry*, IX, 148.

[11] American Iron and Steel Association, *Bulletin*, XIX, 229, Aug. 26, 1885; Bridge, *Inside History of the Carnegie Steel Company*, 164.

[12] American Iron and Steel Association, *Bulletin*, VIII, 314, Oct. 22, 1874; IX, 325, Oct. 29, 1875; IX, 333, Nov. 5, 1875; XVIII, 157, June 18, 1884; XVIII, 161, June 25, 1884; XVIII, 250, Oct. 1, 1884; XX, 189, July 21, 1886; XXI, 165, June 22, 1887; XXI, 181, July 6, 1887; XXII, 133, Apr. 25, 1888; XXV, 389, Dec. 30, 1891; Eleventh Census, *Report on Mineral Industries*, 531, 541, 551; Macbeth-Evans Glass Company, *Fifty Years of Glass Making, 1869–1919*, 31; *cf.* Bureau of the Census, *Mines and Quarries, 1902*, 774.

to represent the first practical application of this fuel to land transportation. The following year oil was used at the plant of the North Chicago Rolling Mill Company, where 14 boilers in the converting department were equipped to burn it, and 21 gallons of oil did the work of one ton of Indiana coal. The oil was slightly cheaper than the coal, but the main saving was in the cost of stoking, unloading coal and wheeling out ashes. The efficiency of the boilers was increased and the report upon this experiment stated that in respect to cleanliness, convenience and economy, oil was second only to natural gas.[13] By 1891 the middle states were described as "full of oil fires, good, bad and indifferent, with all sorts of applications." These could be grouped into three classes, hearth fires, spray fires and gas fires, all of which were satisfactory enough to have received the attention of practical manufacturers.[14]

PETROLEUM REFINING

Petroleum refining continued the movement toward concentration that began before the panic of 1873, when the Rockefellers consolidated several independent refineries in a single company for the purpose of restricting competition, securing lower rates of transportation and stabilizing the prices of their products.[15] In January 1882, an agreement was concluded under which the owners of some fifty oil refineries in different parts of the country surrendered their stock to a board of trustees and received in return certificates representing a proportionate value of the combined properties. This signalized the organization of the first great trust, the Standard Oil Trust, with a capital of about $70,000,000. Its constituent companies were scattered through Massachusetts, New York, New Jersey, Pennsylvania and the states to the westward as far as Iowa and Minnesota. They manufactured all varieties of oil products as well as containers, lamp wicks and other subsidiary articles, were engaged in transporting oil, and in a few cases were producers of crude oil.[16] Ten years later this Trust was dissolved, the certificates being returned to the stockholders of the individual companies. By this time several of the original companies had merged, and all had come almost entirely under the ownership of a few men prominent in the central organization. So the place of the Trust was taken by a group of large corporations owned by the same people who had controlled the Trust itself. At this time the aggregate value of the properties involved was nearly $122,000,000.[17]

So much of the manufacturing connected with the petroleum industry was in the hands of this group of interests that although independent refiners

[13] *Commercial and Financial Chronicle*, XXVII, 422–423, Oct. 26, 1878; American Iron and Steel Association, *Bulletin*, XXI, 173, June 29, 1887; XXII, 339, Nov. 21, 1888.

[14] New England Cotton Manufacturers' Association, *Proceedings, Apr. 1891*, pp. 51–72.

[15] U. S. Industrial Commission, *Reports*, I, 794–795.

[16] *Commercial and Financial Chronicle*, XLVI, 277, Mar. 3, 1888; U. S. Industrial Commission, *Reports*, I, 96; *cf.* Tarbell, *History of the Standard Oil Company*, I, passim.

[17] *Commercial and Financial Chronicle*, LIV, 526, Mar. 26, 1892; U. S. Industrial Commission, *Reports*, I, 97, 301, 799.

and makers of special petroleum continued to exist, its history is virtually identical with that of the dominant combination. In general the influence of the Trust and its successor corporations was to reduce the number of refineries and to concentrate manufacturing in large establishments located at convenient transportation centers. Refining processes did not change radically during this period, but the manufacture of by-products—that is, of products other than illuminating oil—acquired additional importance.[18] Indeed before the end of the century the value of these, including gasoline, naphtha, paraffin, vaseline, and lubricants, equalled the value of the illuminants produced. They thus compensated, if that were necessary, for the rapid encroachment of electricity upon the lighting field. In fact electricity created a new market for paraffin, which was chiefly used for insulating electric wires and apparatus. Vaseline was exhibited as a novel chemical product by two American makers and one Austrian firm at the Paris Exposition of 1878. Gasoline had a restricted market, and was used to some extent in internal combustion engines. But it still sold for six and seven cents a gallon, and even as late as 1893 the immense field of consumption about to be afforded by the automobile was hardly foreshadowed.[19]

The Standard Oil combination controlled over 125 patents, mostly for machines to make cans, boxes, barrels and other oil containers, and for container designs and attachments. But this list also included patents for processes and apparatus used in the manufacture of by-products, and for distributing and burning fuel oil, as well as for a variety of other devices not pertaining strictly to this industry, such as improvements upon the steam engine.[20] None of the inventions thus patented, however, was of such a revolutionary character that its exclusive possession fatally handicapped competitors, as was the case in several other industries like electric lighting.

Between 1873 and 1893 the petroleum output of the United States rose from about 10,000,000 barrels of 42 gallons each to over 48,000,000 barrels. Meanwhile the price of crude oil fell from $1.80 a barrel to one-third that amount; and the price of refined oil declined from 18¼ cents to 5¼ cents a gallon.[21]

COTTONSEED OIL

The manufacture of cottonseed oil developed from a rather casual and precarious industry in the early seventies to a highly organized manufacture of the first rank twenty years later. In 1876 the output was 4,500,000 gallons, of which 1,816,000 gallons were exported. New uses were found

[18] U. S. Industrial Commission, *Reports*, I, 570, 624, 627–628, 798; Tenth Census, *Petroleum and its Products*, 160–162.

[19] U. S. Industrial Commission, *Reports*, I, 570, 628; U. S. Commissioners to the Paris Exposition of 1878, *Reports*, IV, 161–162.

[20] U. S. Industrial Commission, *Reports*, I, 798.

[21] U. S. Industrial Commission, *Reports*, I, 279, 434–435, 568; Eleventh Census, *Report on Manufactures*, III, 364; U. S. Census Bureau, *Mines and Quarries*, 1902, pp. 726–727.

for the product and output rapidly increased, reaching 7,800,000 gallons in 1880. Domestic consumption grew very slowly, however, while exports more than trebled. There were 41 cottonseed-oil mills in the South in 1880, a large proportion of which were in the Mississippi Valley accessible to water transportation. This explains the prominence of Louisiana and Tennessee in this industry, the former state manufacturing nearly two-fifths and the latter one-fifth of all the oil produced in the country. Their mills were centralized at New Orleans and Memphis. The oil cake was largely exported at this time, though some was used for stock feeding in the South.[22] In 1881 there were six mills at New Orleans, all of which were in active operation.[23] A number of mills had already been built in Texas, one of the largest in the country being at Galveston.[24] Memphis, where this manufacture was the chief industry, had begun to make oil just before the outbreak of the Civil War. In 1883 it had 10 mills, manufacturing some 3,000,000 gallons of oil per annum.[25]

Mill owners enjoyed rather precarious prosperity on account of the competition among themselves for seed, a condition which soon led to combinations among buyers. In 1884 such an agreement succeeded so well that the farmers refused to bring their seed to market, and the industry at Memphis received a temporary setback.[26] By 1885 there were 130 mills in the South, or nearly three times as many as five years previously. In fact, this was the period of most rapid plant extension during these two decades. The largest increase was in Texas, where there were 23 mills at the latter date.[27]

By this time it was recognized that the business was overdone. The market was "drowned in oil," and despite heavy exports it had driven tallow down to half its former price, and had caused a fall of 10 to 15 per cent in the price of soap.[28] This rapid expansion attracted the attention of capitalists and large oil consumers. During the early eighties mill owners in Arkansas and Texas formed syndicates for much the same purpose as the temporary association at Memphis already mentioned. About 1884 these consolidated as the American Cotton Oil Trust with much the same form of organization as the Standard Oil Company. The Trust issued certificates for the establishments it took over, the par value of which was very much above—probably more than double—a conservative appraisal of the properties thus assumed. It did not secure a monopoly, but soon controlled 88 per cent of the crushing capacity of the United States, and thus dictated the policies and pooled the profits of the majority of the cotton oil mills and associated establishments in the country.[29] Among the trus-

[22] *Commercial and Financial Chronicle*, xxx, 662, June 26, 1880.
[23] *Textile Record*, ii, 243, Sept. 1881.
[24] *Textile Record*, iii, 21, Jan. 1882.
[25] *Report of Trade and Commerce of Memphis for 1883*, 19–23.
[26] Memphis Merchants' Exchange, *Report for 1884*, p. 17.
[27] *Manufacturers' Record*, vii, 423, May 16, 1885; viii, 178, Sept. 19, 1885.
[28] *Industrial South*, vi, 274, June 17, 1886.
[29] *Commercial and Financial Chronicle*, xliii, 302, Sept. 11, 1886.

tees of the Cotton Oil Trust were N. K. Fairbank, the prominent soap manufacturer of Chicago, and J. H. Flagler, who was associated with the Standard Oil Company.[30]

In 1887 a $4,000,000 corporation was organized in New Jersey, known as the Southern Cotton Oil Company. This was not a trust, but merely a big firm organized to build mills in suitable localities and to handle their product. The Company started out with eight such establishments.[31] In 1888 we find an instance of a large cottonseed-oil mill erected by a guano and chemical manufacturing company; a policy doubtless suggested by the use of mill waste as a fertilizer,[32] although this was by no means the beginning of the association of the cottonseed-oil extraction business with the fertilizer industry.

In 1888 the Cotton Oil Trust faced a suit for dissolution brought by the state of Louisiana. Simultaneously, though not for this reason, it experienced a rather less prosperous season than anticipated. At this time it controlled 163 oil mills and other factories engaged in making cottonseed products. The Southern Oil Company was its largest competitor, and there were in addition 40 independent mills in the business.[33] The following year the Trust reorganized as an ordinary corporation, reducing its capital from more than $41,000,000 to about $30,000,000, as one of the trustees said, in order to "pump out some of the water." The year had not been a prosperous one, and the Company's experience was typical of the vicissitudes of several of these pioneers in modern trust-building. Its representatives had speculated in oil purchased from independent producers and had lost money for the Company by that action. The quality of the oil produced from that year's seed proved to be very poor. In addition the price of seed had fluctuated in a way detrimental to the Company's interests. Thirteen of the 52 crude oil mills which the Trust owned outright were shut down. Three of its 7 refineries were in the same condition, as well as 2 of its 4 soap factories and 1 of its 4 lard plants. It was operating 7 fertilizer factories, 3 compressors and 19 gins in addition. Besides these establishments the Company owned a majority interest in the stock of 11 corporations and a minority interest in the stock of 4 corporations operating altogether 33 oil mills, 13 refineries and a number of other works, including a castor-oil and a linseed-oil mill.[34]

The strongest competitor of the American Cotton Oil Company, as the new corporation was called, continued to be the Southern Cotton Oil Company, which emphasized in its official reports the fact that it was not a trust. This Company was conservatively and efficiently managed. At 6

[30] *Commercial and Financial Chronicle*, XLV, 564, Oct. 29, 1887.

[31] *Manufacturers' Record*, Mar. 12, 1877; XII, 277, Sept. 24, 1887; *Commercial and Financial Chronicle*, XLIX, 145, Aug. 3, 1889; XLIX, 404, Sept. 28, 1889.

[32] *Manufacturers' Record*, XIII, 22, July 14, 1888.

[33] *Commercial and Financial Chronicle*, XLVI, 829, June 30, 1888; XLVII, 139–140, Aug. 4, 1888.

[34] *Commercial and Financial Chronicle*, XLIX, 578–579, Nov. 2, 1889; XLIX, 615, Nov. 9, 1889; XLIX, 689, Nov. 23, 1889; XLIX, 760, Dec. 7, 1889; L, 589, Apr. 26, 1890.

of its 8 mills, and at Philadelphia, it owned refineries for converting crude oil into forms suitable for direct consumption. It also owned a tug and barges on the Mississippi, and a line of tank cars transporting seed and oil.[35]

In 1891, the American Cotton Oil Company, through the medium of an interesting report, informed the public concerning many of the details of its business. Its principal products were cottonseed oil, obtained from the seeds by separating the hull from the kernel, cooking and pressing; cottonseed cake, which was used as a stock food; cottonseed meal, likewise used for feeding cattle and sheep, and also as a fertilizer; linters or short staple cotton salvaged from the seed as received at the mills; and cottonseed hulls, which were used as cattle food, as paper stock, and as a fuel, producing an ash high in potash content employed by tobacco farmers. The oil was refined into various grades known as summer and winter, white and yellow oil, salad oil, and the like; and these were combined with pure beef stearine to make "cottolene," already a popular substitute for lard, and in the manufacture of soap stock, soaps, washing powders and similar articles. It is indicative of the vicissitudes of the industry that of the 127 distinct properties which the Company owned, including oil mills, refineries, lard plants, soap factories, fertilizer factories, compressors and gins, 25—mostly oil mills—were "dormant" and 19 others had been dismantled. The business was only moderately profitable and at this period was paying no dividends to its stock-holders.[36]

In fact the first dividend, of 3 per cent on the preferred stock, was not paid until the middle of 1892, by which time the labor of reorganization had been completed.[37] That year the executive management was simplified by dispensing with the independent companies, which ante-dated the formation of the Trust and had continued to function subject to its control ever since. By this time the Company was again expanding, having acquired several properties during the previous season and rehabilitated some of those which had gone out of operation. Improvements in machinery were introduced, a new type of press more economical than the one previously in use having been perfected that year.[38] The annual report of the Company in 1893 recorded continued expansion, although one or two properties had been sold during the interval. The Trust owned 345 tank cars and in order to handle its foreign business to better advantage it had purchased a tank steamer for carrying oil in bulk to Europe, where it had established headquarters at Rotterdam, which was the principal market in Europe for artificial butter and food oils. Of the 8,356,000 gallons of cottonseed oil received at that port in 1892, nearly 6,000,000 gallons came from the United States. Naturally, the tank steamer was built abroad

[35] *Commercial and Financial Chronicle*, XLIX, 145, Aug. 3, 1889; XLIX, 404, Sept. 28, 1889.
[36] *Commercial and Financial Chronicle*, LIII, 677–678, Nov. 7, 1891.
[37] *Commercial and Financial Chronicle*, LIV, 761, May 7, 1892.
[38] *Commercial and Financial Chronicle*, LV, 746–748, 767–768, Nov. 5, 1892.

and sailed under the flag of Netherlands. Although prices declined about 40 per cent in four months during the panic, the year was upon the whole a profitable one. Cottolene and Gold Dust washing powder were by this time well introduced to the American market.[39] In 1893 Swift and Company and N. Morris and Company, the Chicago packers, arranged to erect a large cotton-oil mill in Arkansas.[40]

As cottonseed oil leaves the press it is not suitable for many uses without refining. The latter process requires more machinery and more highly skilled labor than oil extraction. The transportation economics of the business, therefore, caused crushing mills to be widely scattered, within hauling distance of the farmers who raised the seed they consumed; for it is not profitable to ship raw seed for considerable distance by rail, although it is transported to some extent by water. Oil, being a very concentrated product—some 40 gallons are obtained from a ton of seed—easily stands longer carriage, and from the first some of the principal refineries have been situated in northern cities. In the process of refining, the settlings, or "foots" as they are called, are either used for soap stocks or worked over into a finer product. Refining consists in washing the oil with water and certain chemicals and subsequently filtering. Cold-pressed oils which are the most valuable are used as salad oils or shipped to Europe to be converted into "olive oil." Winter white oil, which is cold pressed, is used in many ways "from the manufacture of medicinal compounds to the miner's lamp." The extraction of the oil from the seed makes it possible to use the residue for stock food and does not lessen its value as a fertilizer.[41]

LINSEED OIL

Linseed-oil milling continued the drift, already noted in the sixties, toward the West, where the oil was extracted from American-grown seed. Nevertheless, considerable quantities of seed continued to be imported and crushed at Philadelphia and elsewhere in the East. In 1890 some 49 western oil mills with 40 elevators and a line of tank cars were combined under the ownership of the National Linseed Oil Company, which took the place of a previous trust, much as the American Cotton Seed Oil Company succeeded the previous American Cotton Seed Oil Trust.[42] But this Company did not have as untroubled a history as its predecessor after changing hands and becoming a regular corporation. Linseed oil does not compete directly with cottonseed oil, as it is not used as a food, nor largely in any field outside the manufacture of paints, oils and linoleum. There is practically no export market such as cottonseed oil makers enjoy. A speculative risk is added to this business, however, by the sympathetic movement of seed prices at home and abroad. For example, in 1891, when silver rose

[39] *Commercial and Financial Chronicle*, LVII, 766–768, Nov. 4, 1893.
[40] *Manufacturers' Record*, XXIII, 86, Mar. 3, 1893.
[41] Burkett, *Cotton*, 282–288; New England Cotton Manufacturers' Association, *Proceedings, Oct. 1877*, 44, 48–49; *Proceedings, Oct. 1879*, 95.
[42] *Commercial and Financial Chronicle*, L, 560, Apr. 19 1890; LI, 348, Sept. 13, 1890.

extraordinarily, a rapid advance occurred in the price of Indian flax seed in all the markets of the world, and American seed rose to correspond. The subsequent decline in the price of silver, accompanied by a simultaneous decline in the price of American seed in sympathy with the falling gold price of Indian seed, caused heavy losses to the National Linseed Oil Company.[43] Its capitalization was nearly one-third less than that of the American Cotton Seed Oil Company, a fact significant of the relative importance of the older and the younger industry. The sale of linseed meal as a stock food tripled during the first thiee years of the Company's existence; sales of oil also rose, and the total volume of business increased to correspond. Nevertheless, the Company failed to make profits during these years. Its trade affiliations brought about negotiations in 1893 for an amalgamation with the National Lead Company, but this was not effected at this time.[44]

THE CHEMICAL INDUSTRIES

In 1892 a specialist in the chemical industries wrote—

> "Of all the arts which we have cultivated and improved, the manufacture of chemicals has made the least progress and received the least attention."[45]

This does not mean that America did not hold a respectable position in some branches of chemical manufacture. Sulphuric acid, which is the basic product upon which the heavy chemical industry rests, was made in the United States by as good methods and at about the same cost as in Europe, although over half the raw materials were imported. Between 1870 and 1880, the production rose from 70,000 to 285,000 tons; in 1890 it exceeded half a million tons; and three years later it reached 710,000 tons. Moreover, America was liberating herself from her previous dependence on imported brimstone by extending the use of pyrites, of which there was an abundant domestic supply. A little more than half the acid made in the country was used to decompose phosphate rocks for making fertilizers; more than one-third was required for refining petroleum, and the remainder was employed in a variety of industries.[46]

Next in importance to sulphuric acid was the manufacture of soda, which was initiated near Bay City, Michigan, about 1880, though the first successful works employing the Solvay process—were started at Syracuse in 1884. Later another plant was erected by a Syracuse Company near Detroit.[47] It was not until the close of the period we are now describing that the electrolytic process began to supersede older methods of alkali production. The international Solvay patents were owned by a group of great companies, each of which had as its exclusive field a single country

[43] *Commercial and Financial Chronicle*, LIII, 223, Aug. 15, 1891.
[44] *Commercial and Financial Chronicle*, LVI, 244–245, Feb. 11, 1893.
[45] *Mineral Industry*, I, 57.
[46] *Mineral Industry*, III, 109; American Iron and Steel Association, *Bulletin*, XX, 181, July 7 and 14, 1886; XXVI, 148, May 25, 1892.
[47] *Mineral Industry*, VIII, 522.

and was entirely independent, so far as ownership and management were concerned, of its sister organizations. But each company had the privilege of sharing in the improvements of all the others, both by constant interchange of technical and factory reports, and by personal visits of its staff experts.[48] During the decade ending with 1890 the country's output of soda increased over 727 per cent, or from 40,000,000 to 333,000,000 pounds.[49]

About 1880 much interest was aroused in utilizing the by-products obtained from the manufacture of charcoal for iron works. The charcoal iron industry was almost everywhere embarrassed by a shortage of fuel. It was discovered that by distilling woods in retorts, a given acreage of timber could be made to produce more charcoal than by any other method, and the by-products were an important source of revenue. The result was a temporary oversupply of acetic acid and acetates.[50] In 1882 a dozen or more iron furnaces as well as a number of print works, powder mills and general chemical companies were producing acetic acid and lime, and within a brief period we changed from an importing to an exporting country of these commodities. Our consumption at this time was about 4,000 tons of acetate of lime per annum.

Carbonic acid was first manufactured in the United States in 1884 and within about a decade a dozen factories were erected using as a raw material magnesite imported from Greece.[51] Alum, which had been made in America since early in the century, continued to be produced within the country in sufficient quantities to supply the home market.[52] Only a single manufacturer was making phosphorus in 1893, and his product was small.[53]

With the development of the West our natural deposits of borax and of soda were developed. The soda lakes of Wyoming and the soda beds of Nevada began to produce for the general market in the early eighties.[54] The price of commercial borax declined one-half between 1882 and 1885 on account of the tapping of the vast supplies in California and Nevada. About this time new fields for its employment were found in soap manufacturing and in meat packing, and a considerable quantity was exported.[55]

FERTILIZERS

The most significant development in the fertilizer industry was in the South. Although Maryland retained her old primacy in this manufacture, South Carolina, profiting by her phosphate deposits and by her position in the heart of the cotton country, advanced between 1880 and 1890 from fourth to third place among the states in value of product, and increased her

[48] *Mineral Industry*, III, 97, 103–107; V, 94.
[49] Eleventh Census, *Report on Manufactures*, III, 278.
[50] U. S. Association of Charcoal Iron Workers, *Journal*, Sept. 1882, quoted in American Iron and Steel Association, *Bulletin*, XVI, 241, Sept. 6, 1882; XVI, 259, Sept. 27, 1892.
[51] *Mineral Industry*, VI, 126.
[52] *Mineral Industry*, II, 5–6.
[53] *Mineral Industry*, II, 541.
[54] *Textile Record*, III, 76, Mar. 1882.
[55] American Iron and Steel Association, *Bulletin*, XIX, 202, Aug. 5, 1885.

output from 65,000 to 294,000 tons; while Georgia, which leaped forward from eleventh to second in rank during this decade was soon to lead the Union in this industry.[56] The amount of phosphate rock mined in South Carolina rose from 6 tons in 1867 to 537,000 tons in 1890; and the quantity of sulphuric acid manufactured within her borders increased from nothing to over 100,000 tons during the 10 years ending with 1890.[57] Florida became an important producer of phosphate rock, its output rising to nearly half of the million tons mined in the United States in 1893. But this state's product, which was partly controlled by German fertilizer interests, was largely exported.[57] During most of this period the Southern rock was carried in large quantities to points on the North Atlantic coast, where it was reduced with sulphuric acid from the older establishments of that section. It was not till the early nineties, that acid works were generally erected in the South, where pyrites were to be had in large quantities, and fertilizer manufacturing showed signs of concentration in that section.[58]

The manufacture of aniline dyes struggled on in a small way for several years after its beginning during the Civil War; and in 1880 American works, all of which were in New York State, produced some 80,000 pounds.[59] Vegetable colors were still used to a very considerable extent by dyers.[60] In 1884 an effort was made under the direction of a Swedish promoter to commence the manufacture of dyes from petroleum refuse at Cleveland.[61] But the production of all of articial dyes, and especially coal-tar colors, languished, although a few firms at Buffalo and elsewhere continued to supply a small fraction of the domestic market.[62]

[56] Tenth Census, *Statistics of Manufactures*, 997; Eleventh Census, *Report on Manufactures*, III, 291.

[57] *Mineral Industry*, I, 369–370; II, 530–537.

[58] *Mineral Industry*, I, 431.

[59] Tenth Census, *Statistics of Manufactures*, 995; *cf*. National Association of Wool Manufacturers, *Bulletin*, XI, 53, Mar. 1881.

[60] *E. g.*, *Textile Record*, IV, 17, Jan. 1883.

[61] *Textile Record*, V, 17, Jan. 1884.

[62] *Cf.* Slosson, *Creative Chemistry*, 82.

CHAPTER XLV

SOME INDUSTRIAL RETROSPECTS, 1873–1893

TARIFF AND CURRENCY LEGISLATION

During most of this period the protective tariff was the principal issue in national politics, a fact indicative of the complete absorption of the nation in home affairs, and also perhaps of that diffidence on the part of our manufacturers which marked the adolescence of American industry. During the era of high protection which began with the Civil War and continued without interruption and almost without criticism until 1872, powerful industrial groups were organized to defend a system of taxation in the continuance of which they believed they had a just and vested interest. In 1872, after several years of great business activity and heavy imports from abroad, the public revenues so clearly exceeded the reasonable demands of the Government, even after liberal provision was made for the reduction of the national debt, that an irresistible popular demand arose for lower duties. Public opinion was further influenced in this direction by the continuance of high prices, especially for many manufactured articles. Consequently, that year a Republican and nominally protectionist Congress made a flat reduction of 10 per cent in the duties on manufactures. The crisis of the following year was accompanied by a heavy and sudden decline in imports and a corresponding falling off of revenues. The economic distress of the country reacted upon political sentiment; and at the next Congressional elections, for the first time since the war, the Democrats won a majority in the lower House of Congress.

Widespread business distress made the minds of the people receptive toward economic fallacies. Sentiment in favor of fiat money in various guises was strong enough to threaten for a time to control legislation. Sounder opinion prevailed, or at least determined the acts of those in power; specie payment was resumed; and in the spring of 1875, during the last session before surrendering control of the lower House to their opponents, the Republicans restored to the statute books the tariff practically as it stood before the reduction of 1872, or at the highest level of the war and post-war era.

Although the Democrats subsequently controlled almost continuously one or both Houses of Congress, they never were in a position to repeal the law of 1875, nor were the Republicans able to amend it in a way that would be satisfactory to their party. This period of divided control in the legislative

and executive branches of the Government continued until 1883, when the Republicans themselves were induced by the growing surplus of revenue, which followed upon the restoration of the country's prosperity and the revival of our import trade, to make considerable reductions. At this time the first of our tariff commissions was appointed, indicating a dawning recognition of the fact that legislation of this kind should be governed as much by economic as by political considerations.

During the decade that followed 1883, the manufacturing interests of the country were kept constantly on the alert by pending or prospective tariff legislation. This incessant agitation finally bore fruit in the McKinley Act of 1890, the detailed provisions of which we need not consider here, except to remark that by embodying provisions for reciprocity, for the first time that they were attempted, or even seriously proposed, in a general tariff law, the framers of this legislation indicated their recognition of the fact that certain of our industries had reached a stage where their prosperity was in some degree contingent upon export markets.

EXPOSITIONS

This period was characterized further by the first great international exhibition ever held west of the Atlantic, and by domestic expositions of national or sectional scope, serving the place of the smaller fairs and municipal exhibitions that had preceded them. The Centennial is a landmark in American manufacturing history. American firms had exhibited the products of our mines and factories and machine shops at international expositions abroad, and in the early fifties we had even attempted with some success to attract foreign exhibitors to a fair of some pretensions in New York City. But the Centennial differed in effect as well as scope from any of these predecessors, so far as its influence on our own industrial history was concerned.

In the first place the American people themselves had an opportunity to compare the processes and products of their own industrial craftsmanship with the best of those abroad. It was the general opinion at the time that we learned little from foreign exhibitors in respect to machinery and mechanical devices. Where other nations surpassed us in this field it was in features which, although important perhaps in the country of their origin, were not likely to prove useful or desirable in the United States.[1] What our manufacturers and the general public did learn from the foreign exhibits was, first and foremost, an appreciation of the refinements of industrial craftsmanship, especially in the application of art to industry; and, second, to compare with more appreciative discrimination than hitherto the excellencies of their own manufactures with those of goods produced abroad.

It is not too much to say that the whole nation took a lesson in art at Philadelphia. A modest but none the less real beginning was made in the

[1] *Cf.* American Iron and Steel Association, *Bulletin*, XI, 141, May 23, 1877.

cultivation of popular good taste. The untraveled public for the first time possessed accessible standards of comparison. On the other hand, some of the prejudices against American goods, especially woolens and other textiles, disappeared when people were able to compare them side by side with those imported.[2] Several American exhibitors later testified to a gratifying extension of their home market for goods that had previously competed at an unfair disadvantage with those of their foreign rivals, as a direct result of the Exhibition. Another effect was to increase the demand for American manufactures in other countries. Indeed, cases were reported in the press, though perhaps on somewhat questionable authority, where manufacturers were forced to enlarge their plants in order to supply a foreign market dating from the Centennial.[3]

An interesting phase of the exposition movement which began at Philadelphia was the opportunity it afforded the Southern States to manifest their growing interest in manufacturing. Atlanta, although at this time a city of only fifty-thousand people, held a Cotton Exposition in 1881 which aroused nation-wide interest and attracted visitors from every part of the United States. Undoubtedly this exposition gave an appreciable stimulus to the industrial revival of the former Confederate states. Four years later New Orleans held a similar mid-winter Cotton Exposition on an even more elaborate scale. The educational influence of these events on the people of the South was marked. Both agriculture and manufacturing were encouraged. They afforded an opportunity for people from both sections of the country to get together and promoted their reconciliation.[4]

TRANSPORTATION

Transportation continued to be characterized by a rapid extension of facilities and by a marked decline in the cost of carriage. Public interest in the regulation of railway rates was awakened, and the influence of transportation charges upon the prosperity, and the very existence of manufacturing industries, was brought prominently to the attention of both manufacturers and the general public. Competition between industries of the same class in different sections assumed new forms; and the financial ties between certain manufacturing and transportation companies became closer.

The panic of 1873 checked railway construction almost as abruptly as the Civil War had done a decade earlier. For five years thereafter the mileage added annually to our railways was less than half the average increase during the five years preceding. Not until 1881, when nearly 10,000 miles were added to the country's transportation system, did railway construction make a new record.[5] During the period of depression in the middle seven-

[2] American Iron and Steel Association, *Bulletin*, XI, 67, Mar. 7, 1877; *Cf.* Trumbull, *Industrial Paterson*, 215–216.

[3] American Iron and Steel Association, *Bulletin*, XI, 73, Mar. 14, 1877.

[4] *Commercial and Financial Chronicle*, XXXIV, 2, Jan. 7, 1882; American Iron and Steel Association, *Bulletin*, XVI, 4, Jan. 4, 1882; *Textile Record*, III, 19, Jan. 1882; *Commercial and Financial Chronicle*, XXXIX, 510, Nov. 8, 1884.

[5] American Iron and Steel Association, *Bulletin*, XXI, 317, Nov. 16, 1887.

ties most of the new mileage was in the older settled portions of the East, especially New York and Pennsylvania.[6] Eras of large construction were periods of development in the West and South. The bridging of the Continent, first accomplished in 1869, was repeated before 1890 by the completion of four other transcontinental lines. Development was especially rapid in the South. Between 1880 and 1889, the mileage of the old South in creased 70 per cent as compared with 52 per cent in the Middle West and 27 per cent in the North Atlantic states. Freight tonnage grew even faster than mileage, increasing 338 per cent in the South as compared with 87 per cent in the Middle West and 83 per cent in the older portions of the North.[7] In 1886 the southern roads simultaneously changed their gage from 5 feet to 4 feet 8½ or 9 inches, the standard gage of the North, thus for the first time in our history giving the whole country a railway system over which freight could be carried without transshipment.[8]

Meanwhile, the cost of moving freight was steadily lowered. On the New York Central it fell more than one half during the decade ending with 1880; and while this ratio of decrease did not occur on the other large systems, there was no exception to the general decline.[9] In a comparison of costs andcharges for moving freight on the Lake Shore and Michigan Southern between 1873 and 1889, it was shown that the traffic carried by this road practically doubled, in round numbers, from 5,000,000 to 10,000,000 tons, while the average charge for moving a ton a mile fell during the same interval from 1.335 to 0.0664 cents. Freight revenues were less in 1889 than 16 years previously, but operating expenses had fallen even more rapidly, partly, to be sure, on account of the deflation of the currency and lower prices, but mainly because of technical economies and traffic development. The substitution of steel rails for iron rails reduced very largely the cost of replacements and repairs; and the development of local supplies of materials used by the road also cheapened operating costs. During the period in question, the average amount paid by the Lake Shore for coal fell from $3.92 to $1.36 a ton, so that in spite of a two-fold increase in business, the total fuel bill of the company was reduced more than half. Train mileage in 1889 was less than in 1873, but the average train load had risen from 136 tons to 255 tons. Therefore the actual cost of moving a ton of freight a mile was 0.946 cents in 1873 and but 0.479 cents in 1889.

Another factor in reducing the costs of transportation, at least in this particular instance, was the tendency to equalize traffic in the two directions. With the diversification of freight which accompanied the development of the country, the east-bound movement of goods upon this line, which had been three times the west-bound movement in 1873, was but one and a half

[6] *Cf. Commercial and Financial Chronicle*, XXVI, 654, June 29, 1878.

[7] *Commercial and Financial Chronicle*, LIII, 954–956, Dec. 26, 1891.

[8] American Iron and Steel Association, *Bulletin*, XX, 137, 154, June 2, 1866; XX, 154, June 16, 1886.

[9] *Commercial and Financial Chronicle*, XXVIII, 490, May 17, 1879.

times the latter in 1889. Effective train mileage was therefore increased in proportion to the total train mileage by the constant growth of the back-load. This change was in no small part attributed to the larger quantities of manufactures and of raw materials used in manufactures carried at the latter date in proportion to agricultural products. In 1873 the grain, flour, provisions and other freight originating on the farm carried by the Lake Shore road amounted to about 2,800,000 tons, while the manufactures, miscellaneous merchandise, iron, lumber, ore and fuel transported amounted to less than 2,400,000 tons. Sixteen years later the former group had remained almost stationary, being still under 3,000,000 tons, while the latter group exceeded 7,000,000 tons.[10]

With the increasing dependence of railways for their revenue upon manufactures and materials employed in manufacturing, the effect of transportation charges upon the prosperity of works and factories became a matter of concern to railroad companies. In 1878 the western trunk lines, for example, made an agreement to charge a relatively low rate on agricultural products and a relatively high rate on manufactures carried eastward, and correspondingly high rates on agricultural products and low rates on manufactures carried westward, an arrangement that western manufacturers found very detrimental to their interests in competing with their eastern rivals.[11] In 1880 officials of the Pennsylvania Railway, arguing before the Committee on Commerce of the House of Representatives, took the position that not only the prosperity but the very existence of the iron and steel industries of Pennsylvania depended upon special treatment by the railways. It was necessary for the producers of bulky staple commodities to know several months or a year beforehand just what it would cost them at some future date to lay down the goods they made at distant markets, where the cost of transportation was a determining factor in their loss or profit. Consequently it had become the custom for railway companies to make long-time contracts, extending over a year or even longer, with such manufacturers, guaranteeing them a specified maximum rate for that period. These rates applied not only to the finished goods but also to ore, coke, limestone and other heavy materials.[12]

Special rate agreements of this character became exceptionally important when they were entered into as an inducement or encouragement to secure the location of an important manufacturing plant upon a particular railway line. A notable instance of an agreement of this kind was that between the Colorado Coal and Iron Company and the Denver and Rio Grande Railway. When the constituent companies which were later combined in the former corporation were being promoted, a determining condition for the success of iron and steel making in Colorado was recognized to be the assurance

[10] *Commercial and Financial Chronicle*, L, 720–722, May 24, 1890.

[11] Bogart and Thompson, *The Industrial State*, 371, citing Interstate Commerce Commission, *Reports*, 6, 195 (204–205).

[12] American Iron and Steel Association, *Bulletin*, XIV, 98, Apr. 21 and 28, 1880; *Cf. id.* XVII, 148, May 30, 1883.

that their natural market would not be invaded by eastern manufacturers assisted by discriminating rates. In 1884 a change of management in the Denver and Rio Grande caused a cancellation of its contract with the Colorado Coal and Iron Company, and the application of local rates to all the shipments of this company, which amounted at times to 34 per cent of the entire freight business of the road. These agreements provided that the Colorado Coal and Iron Company should be given as good rates over the Denver and Rio Grande lines as were given to any other shipper. When the contract was terminated by the railway management, the charge for transporting a keg of nails from Pueblo or Denver to Ogden or Salt Lake City became 11 cents for nails shipped from the east and $1.48 for nails shipped by the Colorado makers. The result was to exclude the Colorado Coal and Iron Company from its former market in Utah, Colorado, Nevada and California, which immediately passed into the hands of eastern competitors.[13]

Another notable effect of railway rates upon the geography of markets was the extension of the sales area of southern iron furnaces to Pittsburgh and beyond, on account of low costs of transportation from the Birmingham district. Some attempts were made to ship pig iron from Sheffield, Alabama, to Pittsburgh and St. Louis by river boats, and a little iron did find its way to market by that route.[14] But the success of southern furnace men in invading the northern field was not due directly or indirectly to water transportation. Steamboat and barge competition never became serious enough to influence railway charges. Meanwhile the prosperity of the railways was closely bound up with that of the growing metallurgical industries of the South. They controlled much of the local traffic in ore, limestone and other materials in the immediate vicinity of the furnaces; and they derived another important part of their revenue by carrying goods to be consumed by the miners of that district. Consequently they were deeply interested in the continuous operation and prosperity of these establishments. But the South had not yet begun to make steel, and its secondary manufactures were in their infancy. Therefore, if southern furnaces were to succeed, they must have, for a time at least, outside markets; and the railways were called upon to create conditions that enabled them to compete in such markets. Indeed, as we have already seen, so successful were southern iron-makers in underbidding their northern rivals, that it was even predicted in the middle eighties that the furnaces along the Atlantic seaboard and in the Ohio valley would eventually cease operation.[15]

While the movement of pig iron from Alabama to Ohio Valley and Pennsylvania points was thus becoming a fact of some commercial importance,

[13] *Commercial and Financial Chronicle*, xxxviii, 261, 294, Mar. 1 and 8, 1884; *Cf.* Phillips, *Freight Rates and Manufactures in Colorado*, 24–25, 60–63.

[14] American Iron and Steel Association, *Bulletin*, xxiii, 333, Dec. 4, 1889; xxiv, 53, Feb. 19 and 26, 1890.

[15] American Iron and Steel Association, *Bulletin* xxiii, 101, Apr. 10, 1889; *Cf. id.* xxvii, 153, May 24, 1893.

the ore trade upon the Great Lakes increased by leaps and bounds. In 1881 a new canal was opened around the falls of St. Mary, permitting the use of larger vessels in the Lake Superior trade. Ore railways were built to Lake terminals, where there were special docks equipped with immense ore pockets from which vessels could be loaded by gravity at the rate of 2,000 tons an hour.[16] Since the Lakes were open only during the summer, and the Bessemer ores of the Lake Superior region could not be shipped conveniently by rail during the season of frost, because they froze in a solid mass which attached itself to the cars, facilities for handling and transporting ore to Lower Lake ports had to be much larger than would otherwise have been needed.

In 1875 it was pointed out to American iron makers that although their industry provided an important fraction of all the freight moved by rail in the country, practically no roads had been constructed for their express convenience, and the existing system was not well designed for assembling economically ore, fuel and flux at any particular point. Nature, by providing two parallel water highways between the East and West—the Great Lakes and the Ohio River—and by placing important ore deposits near the western terminus of each, had in a degree anticipated the transportation needs of the furnacemen of eastern Ohio and western Pennsylvania. The great ore districts of the South were in close proximity to their own supply of fuel. This condition also prevailed in New Jersey and eastern Pennsylvania. Consequently the construction of special roads to carry the raw materials of steel was probably delayed longer than would otherwise have been the case. The farm, rather than the factory, decided the location of our great trunk lines.

POWER

During the two decades ending with 1890 the ratio of power used in manufacturing in proportion to the number of workers employed was constantly increasing. The cost of water per horse-power was rising with the development of the country, while the cost of steam was stationary or declining. Steam passed water as a source of power during the decade ending with 1880, both in the number of units and in the total power produced. As the forests were cleared away in our older manufacturing states, water heads became less reliable. The cost of land rose and the constructions of dams and of reservoirs flooding large areas burdened mill owners with fixed charges much higher than earlier in the century. Indeed, comparatively few factories belonging to the great staple industries continued to generate their power by water as late as 1890. Nearly two-fifths of the horse-power developed by water wheels was used by flour and grist mills, and more than one-fifth by saw mills; while cotton mills used 12 per cent, paper mills 7 per cent and woolen mills less than 5 per cent. The iron industry had ceased to depend

[16] Iron Age, I, 887, Nov. 18, 1892.

on water for blowing furnaces or running forges and rolling mills. Yet some improvements were made that increased the efficiency of turbines, and public interest in water power was apparently greater in the United States than in most large manufacturing countries.[17]

Meanwhile improvements were constantly being made in steam engines and in the construction of boilers. The trend of progress was toward employing higher steam pressure with the object of economizing both space and fuel. Boilers carrying a pressure of over 200 pounds were common before 1893.[18] Increasing nicety of construction and lubrication made it possible to work steam engines continuously for much longer periods than hitherto. In the seventies 2 weeks were considered a long run. Before the end of the eighties engines were running over 13 months without a stoppage, at 500 revolutions a minute.[19] Indeed had it not been for this advance in reliability and speed the progress of the electrical industries would have been sadly hampered. The Porter-Allen engines, used in 1881 to drive the 1,200-light dynamos in the first Edison Company station at New York City, made 350 revolutions a minute.[20] Babcock and Wilcox boilers, maintaining a pressure of 120 pounds, supplied steam for these engines, but what were considered modern plants still worked with a pressure of 75 pounds. Even this was regarded as a notable advance over the 50-pound pressure that had been regarded the maximum a decade earlier. During these ten years the consumption of coal per horse-power had declined from 2 to 1.8 pounds, and the weight of engine per horse-power had been cut in half—or from 500 to about 250 pounds.[21] In the course of the next decade, ending with 1890, steam jacketing and other methods of economizing fuel were generally adopted. It was estimated in 1893 that the cost of steam power had been reduced by one half within the preceding few years.[22]

Rotary engines had been designed and operated at least experimentally in the United States before the Civil War, but the birth of the modern steam turbine dates from the eighties. During this decade the De Laval, the Curtis and the Parsons turbines were being perfected. The last of the three was the first to come into general commercial use in the United States. Its inventor, who had previously experimented with rotary engines of another type, built his pioneer turbine in 1884 and, after the usual tedious process of shop development, put his first large commercial machine in service seven years later. But these motors, which were based on principles discovered abroad, did not come into practical use in the United States until after the period we are now discussing.[23]

[17] American Iron and Steel Association, *Bulletin*, XVIII, 241, Sept. 24, 1884; XXI, 77, Mar. 23, 1887; *The Textile Record*, III, 209, Aug. 1882; *Cf. id.* III, 20, Jan. 1882.
[18] American Iron and Steel Association, *Bulletin*, XXV, 155, May 27, 1891.
[19] American Iron and Steel Association, *Bulletin*, XXII, 129, Apr. 25, 1888.
[20] American Society of Mechanical Engineers, *Transactions*, III, 218–227.
[21] American Society of Mechanical Engineers, *Transactions*, II, 425–428.
[22] New England Cotton Manufacturers' Association, *Proceedings*, Apr. 26, 1893, p. 36.
[23] American Cotton Manufacturers' Association, *Proceedings*, Knoxville, May 1905, 88–89.

Internal combustion engines of the Otto type were becoming familiar in America. They used either a special fuel gas or ordinary illuminating gas, and were employed to drive pumps and light machinery,[24] but not as yet to propel vehicles. The automobile, as the basis of a manufacturing industry, had not yet arrived in the United States. Electrical transmission was not generally introduced until after 1893; but compressed air was employed in a few places on a rather ambitious scale. A large power station was installed at the eastern end of the St. Louis Bridge with compressors from which air was piped to various points on both sides of the Mississippi. It operated the entire switch and signal system of the bridge and tunnel over a district of nearly 3 miles, and was used to drive pumps and engines in the Bridge Company's shops.[25]

[24] *Cf.* New England Cotton Manufacturers' Association, *Proceedings*, Boston, Apr. 1882, 42–46.

[25] American Iron and Steel Association, *Bulletin*, XXI, 347, Dec. 21, 1887.

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